MACHINERY.

July, 1908.

CAM APPLICATIONS.*

MECHANISMS EMPLOYED IN CONNECTION WITH CAMS.

GEORGE W. ARMSTRONG.†

George W. Armstrong.‡

CAMS and their attendant levers, considered merely as simple machine elements, are without doubt the most versatile of mechanisms; and, when subjected to the designer's consideration, may be developed along such diverse lines, and made to exhibit such limitless possibilities, as are shared in no comparable degree by any other elementary mechanical principles at his command. Even with all their inherent adaptabilities, however, their field may be greatly extended by conjunctive appliances devised to control or modify their motions and applications in various ways. It is the purpose of this article to illustrate several such devices designed by the writer. Some of these performed their functions very satisfactorily, and appear as features in patented machines, while others never reached the stage of practical application, although this need not detract from their interest as theoretical mechanical movements.

Cam Combination Movement No. 1.

Figs. 1, 2, and 3 represent the solution of three inter-dependent problems. The requirements of the one illustrated by Fig. 1 were that two bell crank levers, working oppositely,

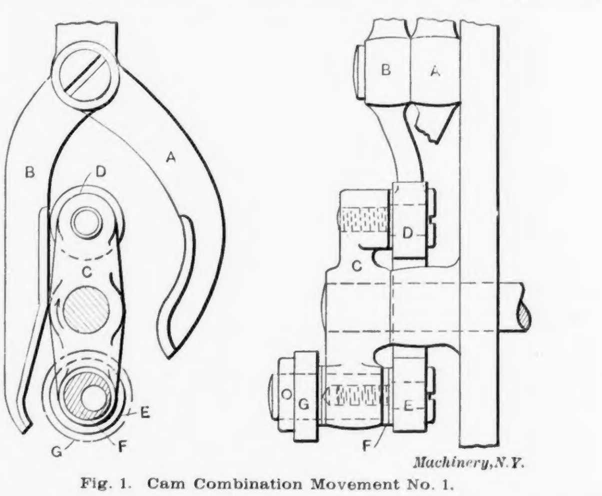

Fig. 1. Cam Combination Movement No. 1.

should transmit to other machine elements a variable motion, differing in each lever (the kind of motion, length, or time not being pertinent to this discussion). Every other vibration of each lever must be through a certain angle a; the alternate vibrations of each lever must have the angle a varied through a cycle of twelve vibrations from a maximum to a minimum, and vice versa, in harmonic ratio, a being the mean.

Levers *A* and *B*, with properly shaped cam arms, are operated by the rolls on arm *C*, which alternately engage the lever cam surfaces. The roll *D* gives the angle a. Roll *E* is eccentrically fastened to the bushing *F*, which is rotated in its seat by the star wheel *G* one-twelfth of a revolution per revolution of arm *C*, thereby carrying the roll to and from the center to vary the angle of vibration according to the imposed conditions.

Cam Combination Movement No. 2.

Another mechanism, acting with the above, presents to a certain extent somewhat similar conditions. An irregular vertical line *G*, Fig. 2, is desired reproduced by the upper end of a lever as follows: For one vibration the line must be re-

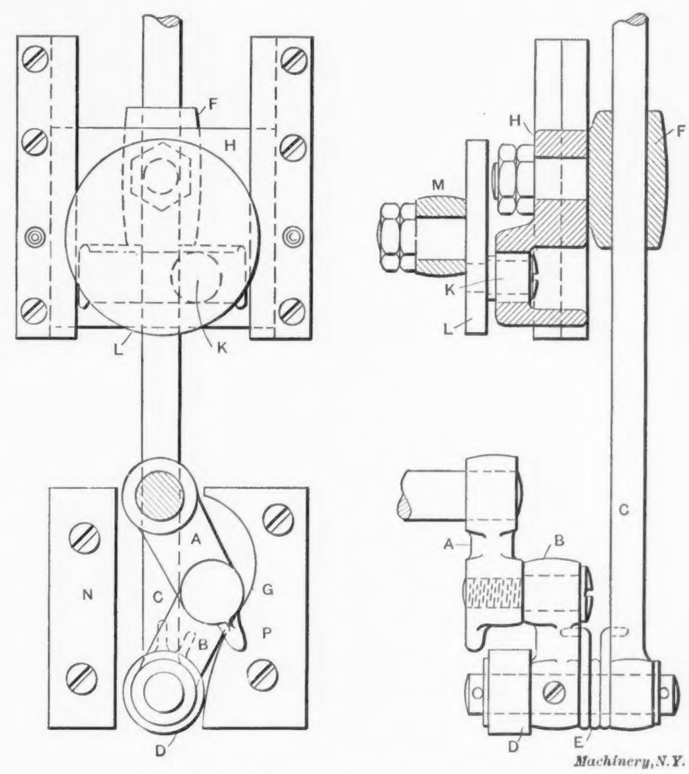

Fig. 2. Cam Combination Movement No. 2.

produced exactly; this is the mean vibration of a cycle of twelve, in each of which the line is reproduced to an increased or diminished scale, to the maximum or minimum, or vice versa. The amplitude of variation of the reproduced line per vibration must be by harmonic ratio. Further, the lever must return in a straight line.

Crank *A* and connection *B* reciprocate the lever *C* and the roll *D* which is kept in contact with *G* by spring *E*. The lever *C* is fulcrumed and slides in the oscillating bearing *F*, which is supported by the slotted cross-head *H*. This is operated by roll *K*, fastened off center on a twelve-tooth ratchet *L*, supported by a bridge-bearing *M*, over the cross-head ways.

In action, the crank throws the connection *B* out of line with the lever *C*, which results in the spring *E*, by reason of the introduced tension, forcing roll *D* to follow the outline of *G* till the highest point is reached, whereupon the connection becomes out of line on the opposite side, and constrains the spring to hold the roll against the straight return guide *N*. During every revolution, the pawl *P* turns the wheel *L* one tooth, raising and lowering *H* and *F*, thereby assuring the proper magnification and diminution of *G*.

Cam Combination Movement No. 3.

Fig. 3 represents the third problem. A horizontal lever must be given a transverse movement along a bar, upon

* For additional information on this subject see "Laying Out Cams for Rapid Motions," February, 1908, and other articles there referred to.

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which it is fulcrumed, during the 90-degree dwell of its operating cam; the speed of the movement must decrease by harmonic ratio as it approaches the middle of its travel from each end, and increase as it recedes; while the lever must be

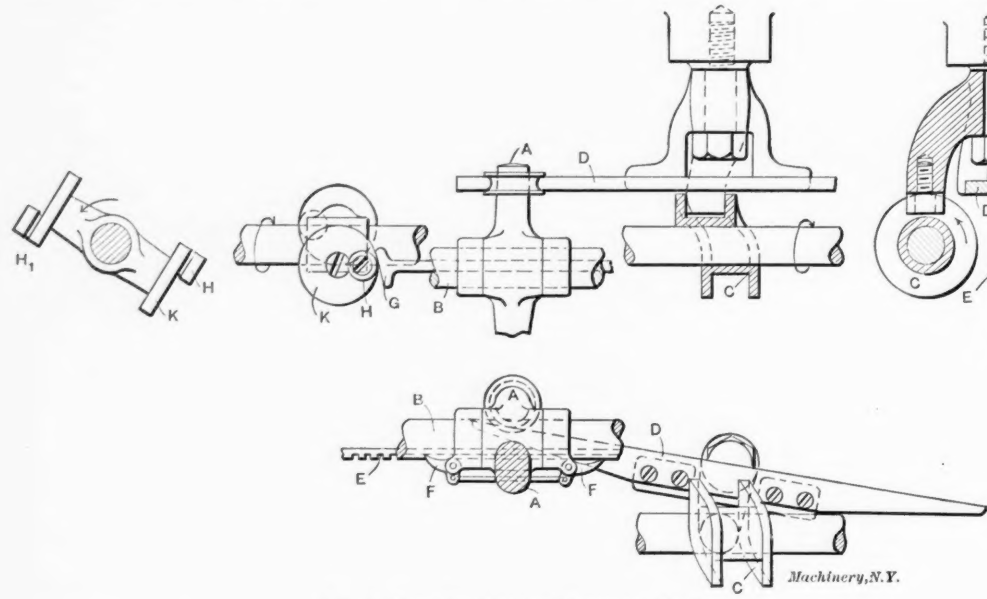

Fig. 3. Cam Combination Movement No. 3.

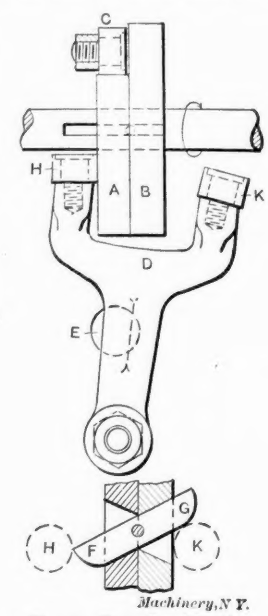

Fig. 4. Cam Combination Movement No. 4.

vibrated through smaller angles as it approaches the middle, and greater angles as it recedes.

Lever *A*, pivoted upon *B*, is vibrated by means of cam *C* and rocking bar *D*. Bar *B* is splined to accommodate a ratchet *E*, with which one of the pawls *F* engages. At each end of the

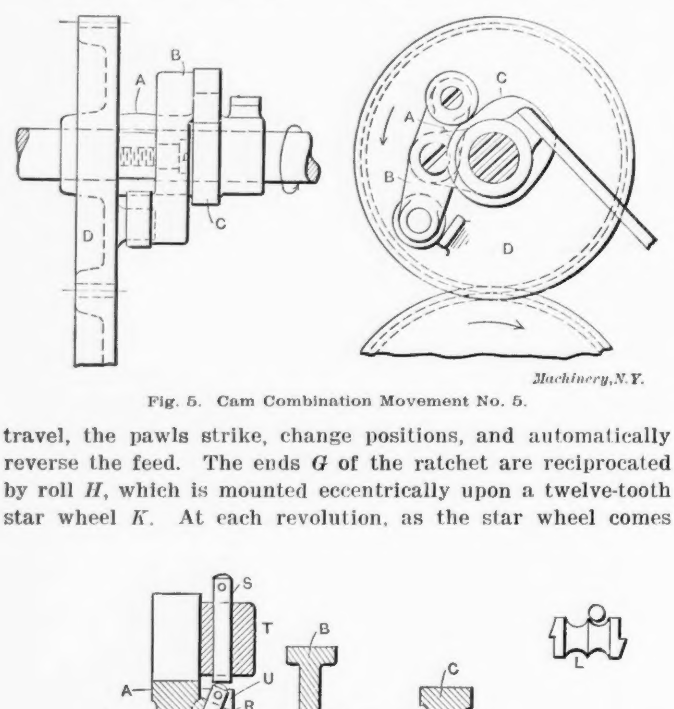

Fig. 5. Cam Combination Movement No. 5.

travel, the pawls strike, change positions, and automatically reverse the feed. The ends *G* of the ratchet are reciprocated by roll *H*, which is mounted eccentrically upon a twelve-tooth star wheel *K*. At each revolution, as the star wheel comes

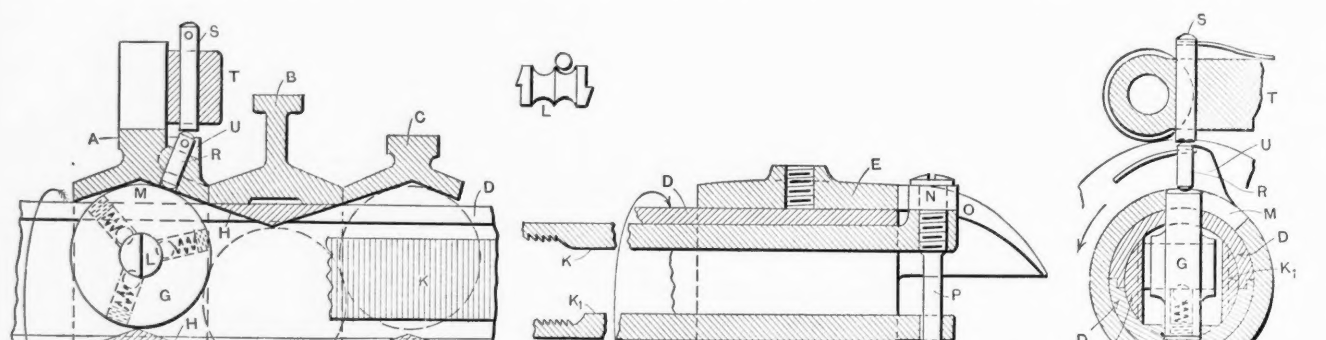

Fig. 6. Cam Combination Movement No. 6.

opposite the ratchet, a stationary pin turns it one tooth, throwing the roll out from center and moving lever *A* along. When the lever is farthest to the left, the roll *H* is in line with the ratchet and star center, and between them. This position gives the maximum movement to the ratchet. The roll is thereafter thrown further out of line, decreasing the feed until the lever reaches the middle distance, after which the roll H_1, on the opposite end, comes into action to complete the movement in an increasing ratio. Another set of star wheels and rolls on the other end of the shaft, gives positive motion and return to the ratchet in both directions.

Cam Combination Movement No. 4.

Fig. 4 shows an arrangement where two revolutions of a cam are necessary to give the required movement to the lever. The rise and the dwell require one revolution each. Two cams *A* and *B*, fastened together, can slide upon the shaft a distance equal to the face of one, by reason of a spline and a key. The motion is taken off by roll *C*, which is shown in the engraving resting on spiral cam *A*. Cam *B* is an entire circular disk. The shifting lever *D* is operated on the "load-and-fire" principle, *E* being a spring plunger. In the cams, and pivoted between them, above the key, is a double-ended cam *F* and *G*, omitted for clearness from the large figure. This swings until it rests against the sides of the opening.

In operation, the cam *A* lifts the roll to its highest point, when lever *D* slides the cam along, leaving the roll *C* upon cam *B* for the dwell of one revolution, when the cam is immediately shifted in the opposite direction for an instantaneous drop. With the lever and cams as shown, *F* engages roll *H* and forces it to the left until *E* acts to throw the lever and the cam the full distance over. If *F* and *G* were stationary, they would interfere with the rolls *H* and *K*, and be inoperative, but being pivoted, the end out of engagement is swung forward to clear its roll before the other end throws the roll on this side over.

Cam Combination Movement No. 5.

Fig. 5 shows a method whereby a shaft, making the same number of revolutions as its driver, is rotated at variable

speeds. The driving shaft carries the casting A to which is fulcrumed the lever B, which in turn has a roll on each end. One roll engages a cam C, supported upon the shaft, but not revolving with it. The other roll bears upon a lug on the side

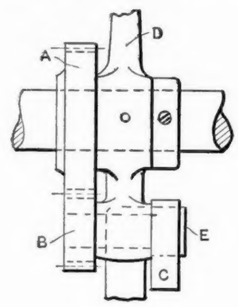

Fig. 7. Cam Combination Movement No. 7.

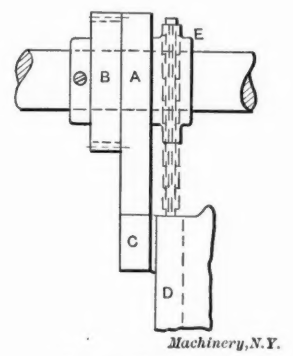

Fig. 8. Cam Combination Movement No. 8.

of gear D, which is also free upon the shaft, but is constrained to revolve with it either faster or slower, according to the relative positions of lever B and cam C.

Cam Combination Movement No. 6.

A problem entailing a group of five dissimilar cams upon one shaft presented these requirements: The cams must operate their respective levers successively back and forth from end to end of the group; that is, while any one operates its lever, all the others must remain stationary with their lever-rolls on a 90-degree low dwell. It requires eight revolutions of the shaft to complete one cycle.

The design adopted to carry out these provisions is shown in Fig. 6, in which the hollow shaft D, carried in bearings E, supports the cams A, B, C, etc. A roll key G is caused to move inside of the shaft from end to end. The roll is constrained to follow the inclines H, and is drawn along its sinuous course by ratchets K and K_1, and a pawl L, it being obvious that G will key each cam in succession to the shaft as it enters its respective keyway M. Within G a double-ended pawl L is held in engagement with either ratchet K or K_1 by balls and springs. The ratchets are cut oppositely and are reciprocated by roll N and cam O. Roll screw P constrains both ratchets to reciprocate together, and a similar equipment on the opposite end makes the motion positive. When the roll has keyed the last cam, the return of the ratchet causes the pawl to rise onto a higher surface, thereby throwing it into mesh with the other ratchet, and effecting the reversal. It will be noticed that, in the engraving, the part of the longitudinal section to the right is

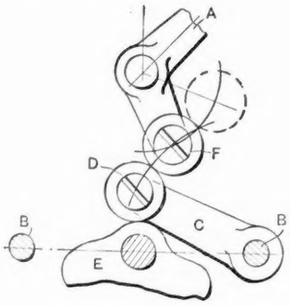

Fig. 9. Cam Combination Movement No. 9.

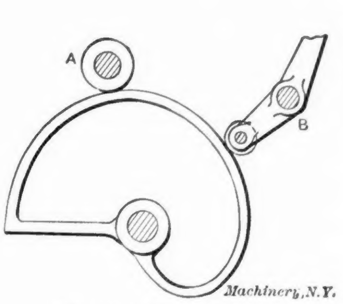

Fig. 10. Cam Combination Movement No. 10.

turned around 90 degrees in relation to the portion at the left. This was done to show more clearly the construction.

To hold the cams positively while they wait their turn, knock-out pin R is resorted to in connection with the catch-pin S in lever T. Just as roll G starts to drive the cam, it pushes out R and raises S above the lug U, freeing the cam from the lever.

Cam Combination Movement No. 7.

A lever is to be vibrated twice per revolution of a shaft, which shaft is to be the fulcrum of the lever. A gear A, Fig. 7, upon the shaft drives the pinion B and cam C which have a bearing in the end of lever D. The cam runs over a stationary roll E, and vibrates the lever about the shaft as a center.

Cam Combination Movement No. 8.

Fig. 8 shows how a shaft may be rocked by a cam which is located upon itself. The cam A, fast to gear B, is driven from an outside source, and reciprocates the roll C and the radial slide D. A chain passes over a sprocket E which is fast on the shaft. One end of the chain is fastened to the slide D, the other is fastened to a tension spring beneath the slide.

Cam Combination Movement No. 9.

Referring to Fig. 9, it was desired that lever A should have an angular displacement of 45 degrees, but it was found that a cam to accomplish this with the given center distances would not swing inside the rods B. The idler lever C was resorted to, and, as first designed, was connected to the lower

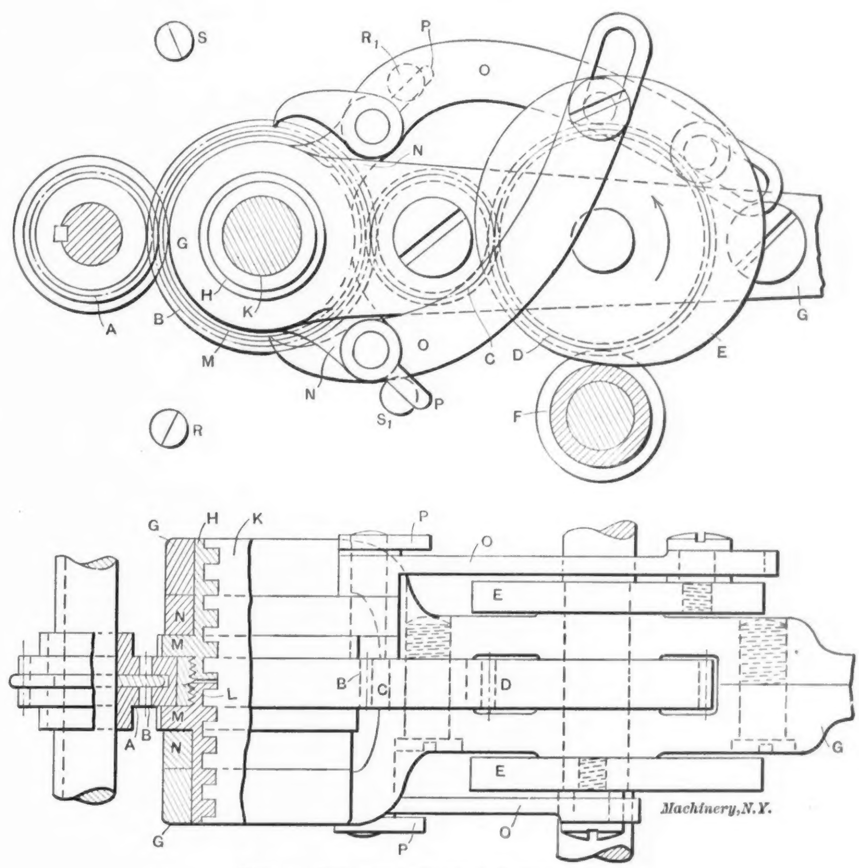

Fig. 11. Cam Combination Movement No. 11.

arm of A by a link. As made, however, the roll D on C ran between the cam E and the lever roll F, allowing a much smaller cam and giving a very smooth movement.

Cam Combination Movement No. 10.

How one cam was made to operate two machine elements is shown in Fig. 10, where the cam was designed to reciprocate the roll A and its slide, giving it a 90-degree dwell after the rise and while lever B was vibrated. By properly positioning the fulcrum and proportioning the arms of lever B, the necessary motion for it was taken off the last part of the rise of the cam. Roll A is shown at the beginning of dwell and the cam is about to throw lever B.

Cam Combination Movement No. 11.

A cam is desired to vibrate a third-class lever, and while at its lowest dwell (100 degrees), the lever must be given a lateral translation of 1/16 inch. The total travel each way is 6 inches, and the feed must be automatically reversed at each end.

The manner of accomplishing this is delineated in Fig. 11, in which pinion A drives idlers B and C and cam gear D. The pinion is keyed on the shaft, and is built up with a flange which engages a groove in gear B, causing it to follow the gear. Two like cams E are driven by D, and bear against flanged roll F. The lever G swings about its fulcrum H which is a two-part nut upon the stationary screw K. The nut is divided, the halves being united by sleeve L. The flanges M on each nut are provided with oppositely cut ratchets. Rockers N carry the pawls being actuated by the connections O. In order that the required translation may be imparted to the lever by the four pitch nut, the pawls must swing through an arc of 90 degrees. The engraving shows the parts in position to do this.

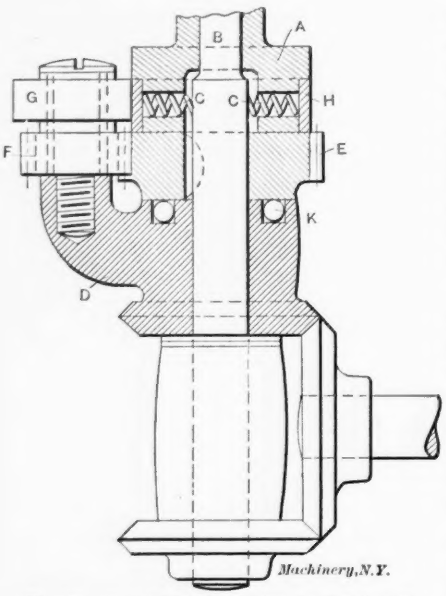

Fig. 12. Cam Combination Movement No. 12.

The reversal is accomplished by the projections P on the pawls and two pair of spring plungers; R and R_1, being on one side of the frame, and S and S_1 being on the other side. As the lever travels away from us, the pawls approach R and R_1. At the last 1/16 feed, R recedes to let its pawl pass, but throws it into the ratchet on its return. Plunger R_1 recedes to allow the pawl to pass by, but immediately lifts it out of its ratchet.

Cam Combination Movement No. 12.

The accompanying Fig. 12 shows how a circular part making thirty revolutions per minute clockwise, in a horizontal plane, was vibrated from and to its center twice per second, the vibrations being applied progressively counter clockwise around its center, and the part being vibrated vertically sixty times per minute. The part A to be vibrated is revolved by shaft B,

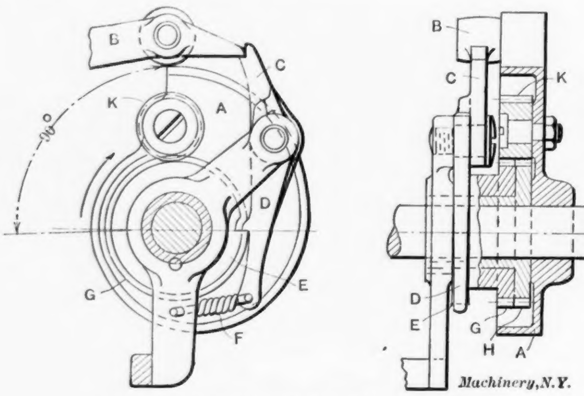

Fig. 13. Cam Combination Movement No. 13.

and centered about it by three springs C. The arm D revolves in the opposite direction to A and the gear E of twenty teeth, which results in the pinion F revolving four times per revolution of arm and part A. The pinion carries a cam G which is made of rubber. It presses against the slip ring H and vibrates the part A. The ring is provided to prevent any drag by reason of the opposite directions of rotation. The balls shown at K serve to reciprocate the part A vertically by reason of the annular groove having two barriers against which the balls stop, and part E having two cam projections which enter the groove and roll up over the balls.

Cam Combination Movement No. 13.

The cam A in Fig. 13, elevates lever B during three-quarters of a revolution. The latch C holds it up during 90 degrees dwell. This latch is controlled by the pawl D, cam E, and spring F. Cam E has ratchet-like notches in its edge, and is made in one piece with a 24-tooth gear G. The pair is rotated upon the hub of a 25-tooth stationary gear H by the planetary pinion K, once every twenty-four revolutions of cam A.

It is desired that the lever B should have 90 degrees dwell the first revolution; thereafter the dwell should increase 360 degrees after each rise to the fourth period (which gives 1,530 degrees dwell), when the dwell should decrease till it is 90 degrees again; that is, during the fourth period the rise is three-quarters of a revolution, and the dwell is $\frac{1}{4} + 4$ revolutions.

This requires 24 revolutions per cycle, and cam E should be indexed for 24 divisions, but only cut at these divisions: 1—2—4—7—11—16—20—23. When pawl D drops into a notch, latch C is thrown out, giving a sudden drop to lever B.

Cam Combination Movement No. 14.

Five levers equally spaced are fulcrumed upon one bar. Four different positive motion side cams operate the four outside levers. The fifth or middle lever is to have the resultant motion of the others at all times; that is, the forces acting on the other four are to be automatically resolved, and their resultant in magnitude and direction is to be transmitted positively to the fifth lever.

As it is not necessary to show the cams or levers to illustrate the principles involved, a horizontal section, merely, of the resolving apparatus will be shown. The four levers are suitably connected by knuckle-joints, one to each of the racks L, M, N and O, Fig. 14. These racks are free to slide up and down independently, and are arranged in two pairs. One pair meshes with pinion A_1, the other with A_2. As the arrangement is symmetrical, the description of one side will suffice. Any movement of levers L and M will be transmitted to pinions A_1 and B_1, which are constrained to travel together by reason of a stud through both. A stationary rack C_1 and a sliding rack

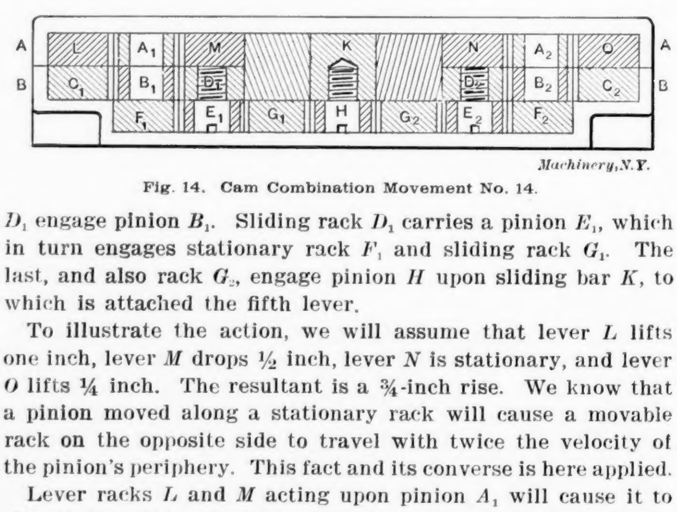

Fig. 14. Cam Combination Movement No. 14.

D_1 engage pinion B_1. Sliding rack D_1 carries a pinion E_1, which in turn engages stationary rack F_1 and sliding rack G_1. The last, and also rack G_2, engage pinion H upon sliding bar K, to which is attached the fifth lever.

To illustrate the action, we will assume that lever L lifts one inch, lever M drops ½ inch, lever N is stationary, and lever O lifts ¼ inch. The resultant is a ¾-inch rise. We know that a pinion moved along a stationary rack will cause a movable rack on the opposite side to travel with twice the velocity of the pinion's periphery. This fact and its converse is here applied.

Lever racks L and M acting upon pinion A_1 will cause it to rise $\frac{1}{2}(1 - \frac{1}{2}) = \frac{1}{4}$ inch. This travel is doubled in sliding rack D_1, producing a movement of ½ inch, and doubled again in sliding rack G_1, throwing the latter 1 inch. As G_1 has teeth on both sides, it, in turn, moves pinion H, and the fifth lever slide K, ½ inch. Lever racks N and O traced out as above give a movement of ½ inch to G_2 and ¼ inch to H and K, which totals ¾ inch rise for the fifth lever. When all cams drop 1 inch together, the resultant is 4 inches drop for the middle lever.

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It is mentioned in the *Times Engineering Supplement* that a new steam turbine of novel design has been brought out by Mr. John Ogg, Aberdeen, Scotland. The turbine consists of a metal wheel or disk mounted on a hollow shaft perforated by holes passing from the center to the inside of the wheel, radially. The holes are tapered from the center outward and form expanding nozzles for the steam, which is supplied through the hollow shaft. The steam, on issuing from the nozzles, strikes against blades fixed to the rim of the wheel at a suitable angle. Several wheels may be mounted on the same shafts and the blades on some of the wheels may be set for the forward motion and others for reverse motion.

GRAPHICAL SOLUTION OF CROSS-ROLL CURVE PROBLEM.*

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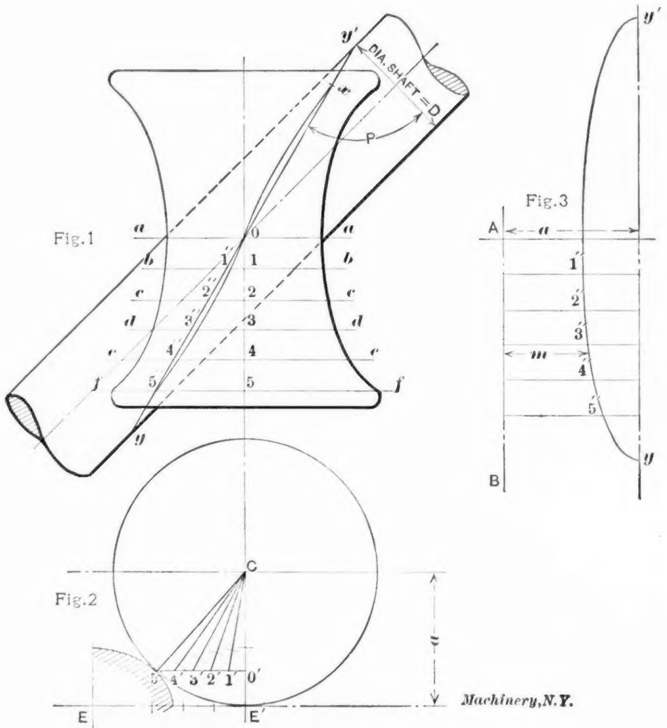
In the present article the writer offers a method of constructing the cross-roll curve. This method will be found fully as accurate, and far easier to handle, than the more complicated formulas which have been suggested for the same problem.

After laying out the shaft and the center line of the roll, as in Fig. 1, the first step is to determine the line of contact between the roll and shaft. Taking a section on the line *ff*,



Graphical Solution of the Cross-roll Curve.

at the end of the roll, draw the ellipse forming the section of the shaft on this plane, as shown in Fig. 2. From *C*, the center of the roll, draw a circle tangent to the ellipse, and locate the point of tangency 5′, as closely as possible. This point is the point of contact between the roll and the shaft on the plane *ff*. Projecting 5′ to Fig. 1 we obtain the point 5″. The straight line from 5″ to 0 represents the average direction of the line of contact. Produce 5″ 0 in both directions till it cuts the sides of the shaft at *y* and *y′*, and draw the ellipse which represents the section of the shaft on *yy′*, as shown in Fig. 3. This ellipse should be constructed as accurately as possible. The minor axis, of course, equals the diameter of the shaft, and the major axis equals $\frac{D}{\cos a}$.

At a distance *a* from the major axis of the ellipse, equal to the vertical distance between the center lines of the roll and shaft, draw *AB* parallel to the major axis. In Fig. 1 divide 05 into a number of equal parts, and through these points draw *bb*, *cc*, etc., cutting *yy′* in 1″, 2″, etc. These are the points of contact on the sections *bb*, *cc*, etc., assuming the contact line to be straight. Now revolve the ellipse *yy′* into the plane of the roll axis. Points 1″, 2″, etc., will take the positions shown in Fig. 3, and *AB* will be the center line of the roll. Erect ordinates on *yy′* passing through 1″, 2″, etc., and produce them to *AB*. Under the conditions assumed it is evident that the distance *m*, on any ordinate, from *AB* to the curve of the ellipse, is equal to the radius of the roll section at that point. Revolving the ellipse back to its real position, point 5″ will assume position 5′ in Fig. 2; the real radius of the section will be *C*5′, and the distance between 5″ and *AB*, Fig. 3, will equal *C*0′. But *C*5′ equals $\frac{C0'}{\cos 5'C0'}$. Therefore, denoting the distance from *AB* to the curve of the ellipse by *m*, angle 5′*C*0′, 4′*C*0′, etc., by *F*, and the radius of the roll section by *R*,

$$R = \frac{m}{\cos F}$$

Angle *F* can be obtained by dividing 5′*C*0′ into angles corresponding with the other points of division, and *m* must be measured from Fig. 3. The formula, however, is not exact, though it is very close. The method of obtaining *F* gives the correct angle, but *m* is slightly too small, for the real point of contact, instead of being on the straight line 5″0, is on the curved line 5″0. A little consideration will show that the real line of contact is an arc over the surface of the shaft, as represented by the curve 5″0*x*, while the straight line 5″0*x* represents the chord *through* the shaft.

If the construction is very carefully done, the following method gives very close results. After obtaining 5′, Fig. 2, the point of contact on the section *ff*, draw 5′0′ perpendicular to *C*0′ and divide it into equal parts, corresponding to the divisions on 05. Draw *C*1′, *C*2′, etc. Now divide *EE′* into the same number of parts. The division points represent the center of the shaft section on the planes *aa*, *bb*, *cc*, etc. For each position, draw that portion of the ellipse which is normal to the corresponding line from *C*. The point of intersection will be the point of contact for the corresponding plane in Fig. 1, and the radius can be measured directly, or transferred to Fig. 1, and the curve for the outline of the cross-roll drawn. The accuracy of the result depends upon the care with which the ellipse is constructed for the different positions.

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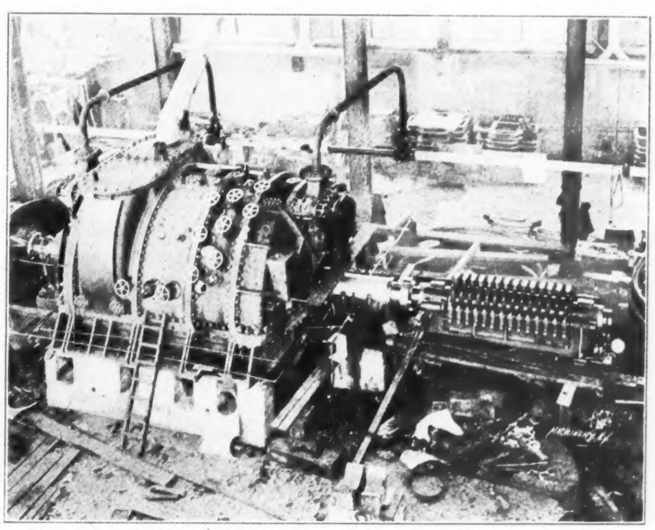
GIANT TURBINES FOR JAPANESE CRUISER.

There have just been completed at the Fore River Works, Quincy, Mass., a pair of giant turbines, destined for the new Japanese cruiser *Ibuki*, now building in a Japanese yard. These turbines will develop on aggregate of 27,000 horsepower, and the cruiser will have a speed of 23 knots, with 14,500 tons displacement. The turbines are 144 inches in diameter, with seven ahead and two reverse stages, contained in one casing. The reverse wheels will develop about 60 per cent of the full-ahead power, and reversing can be accomplished in eight to ten seconds from the time signals are given. These will be the first turbines ever installed in a Japanese ship, and are to be followed by two more of similar



One of the Turbines built at the Fore River Works, Quincy, Mass., for a Japanese Cruiser.

design for the battleship *Aki*, now under construction. The boxed weight of the turbines just finished was 450 tons. Each separate part was securely boxed, marked and numbered, so that the parts can be readily fitted together when Japan is reached. A diagram was made of the vessel which carried the parts of the turbines before the crates were hoisted aboard, in order that there might be no movement in the hold that would cause damage to any of the parts in rough weather. Several workmen from the Fore River Works are going to Japan to assist in setting up the turbines. The building and shipping of the turbines were under the direction of Commanders Yushida and Kamimura of the Japanese navy.

* For additional information on this subject, see the article in the December, 1907, issue, on the "Derivation of the Cross-roll Curve," and other articles there referred to.
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ADAMS-FARWELL AERONAUTIC GASOLINE MOTOR.

The flying-machine inventor is not so much ridiculed nowadays as of yore, for attempting to accomplish mechanical flight. The Darius Green type of flying machine inventor, among whom was the ill-fated German, Otto Lilienthal, laid a foundation of practical knowledge of air resistance, air currents and the laws affecting the action of gliders and aeroplanes; and to-day the possibility of navigating the air looms before us. Lilienthal began his experiments in 1891, and was killed by an accident to his glider in 1896. Although his work was generally regarded with contempt at the time, Lilienthal's investigations were the start of work along the same lines that is of much interest and value now. It is with the advantage of the principles established by such men as Lilienthal that the present experimenters are enabled to attack the problem of "heavier-than-air" flying machines, intelligently. They are generally men of expert engineering and mechanical knowledge, such as the Wright brothers, Henri Farman and Leon Delagrange, and their work is regarded with respect, because we are beginning to understand what the requirements are and how they are to be met. The successful solution of flying, which is believed to be not far distant, will mean a tremendous change in light transportation and sport. The engineer is interested in the practical side. He knows that birds fly because of possessing great muscular power and wing surface, as compared with their weight. It does not necessarily follow, however, that a flying bird continually exerts great power; in fact, we have very good proof that it does not, but it must always have large reserve power to enable it to rise quickly from the ground and to suddenly change its course when the air currents do not favor progress. So it must be with the mechanical flyer; hence the need for powerful and light motors.

The accompanying half-tones, Figs. 1 to 4, show a new aeronautic motor developed for an Eastern inventor who is making secret tests of a new type of aeroplane. The motor is the design of F. O. Farwell, inventor and patentee of the revolving cylinder motor first used on the Adams-Farwell automobile. (See MACHINERY, November, 1904, for description.) The automobile engine described had three cylinders revolving around a stationary crank-shaft, and a 20-H.P. engine weighed 190 pounds, or 9½ pounds per H.P. This design was afterwards changed to five cylinders, and the aeronautic motor shown herewith is built from the same patterns with the exception that the bore is 4¼ inches, instead of 4 inches. It is lightened by making some other changes also. The engine illustrated has five cylinders, 4¼ inches bore, 3½ inches stroke, and runs at 1,800 R.P.M. Its weight is only 97¼ pounds, and figured by the Association of Licensed Automobile Manufacturers' rule, H.P. $= \frac{D^2}{2.5} \times N$, its rating is 36 H.P., or only 2.7 pounds per H.P. This weight includes everything necessary for operation, with timer, float-feed carbureter, automatic force-feed oil-pump and lubricating oil tank. With the spider shown in the half-tones, Figs. 2, 3, and 4, which secures the motor to four tubes, the motor and base weigh 104 pounds. The parts not included in this weight are the battery, coil and gasoline tank, which cannot be considered as parts of the motor.

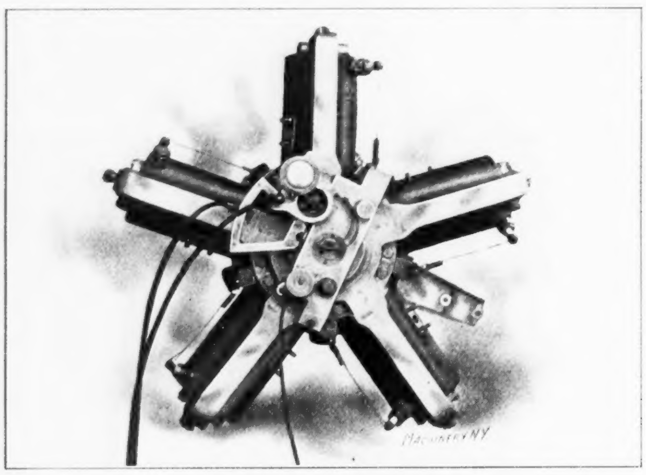


Fig. 1. Top View of Adams-Farwell Five-cylinder Motor for Air Ships and Aeroplanes.

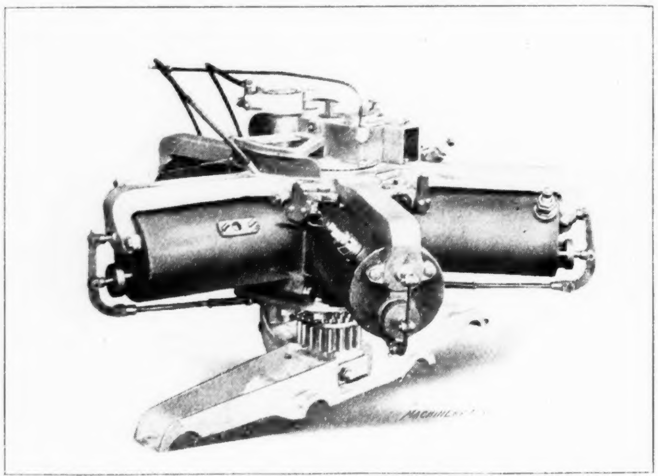


Fig. 2. Side View of Five-cylinder Motor, showing Spider for Attaching to Frame.

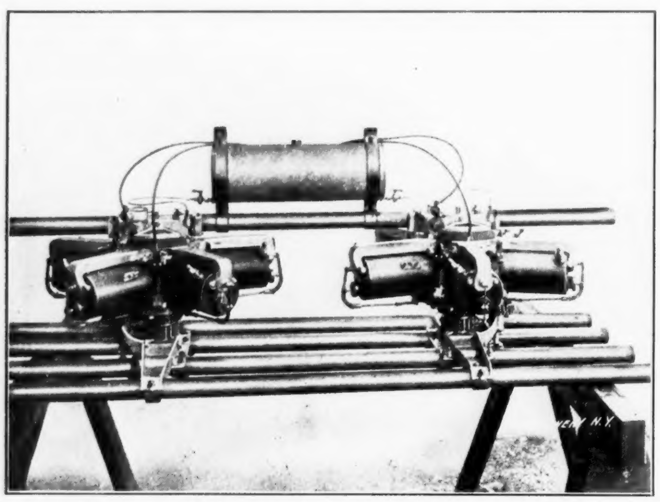


Fig. 3. Two Motors attached to a Frame of Tubes, with Complete Equipment.

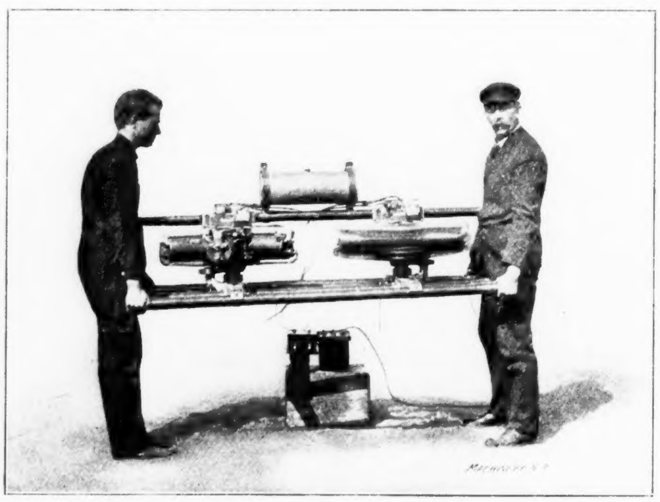


Fig. 4. Two Motors supported by Two Men. One Motor is shown running at High Speed, Illustrating Freedom from Vibration.

The above weight per H.P. developed is believed to be the lightest of any motor so far built in which practical utility was not sacrificed. The nearest approach is the Antionette eight-cylinder motor, made by the Adams Mfg. Co., Ltd., London, England. The weight of this engine for 31.71 H.P., by the A. L. A. M. rule, is 88 pounds or 2.77 pounds per H.P. The larger sizes are heavier per H.P. This motor is water-cooled, and requires considerable additional weight for the water, water pump, piping and radiator. Another very light motor, built by the G. H. Curtis Mfg. Co., Hammondsport, N. Y., weighs 150 pounds for 40 H.P. or 3.57 pounds per H.P.

The construction of the Farwell motor is peculiarly advantageous for aeronautic purposes. The cylinders form the fly-wheel, and this fact alone means a big saving in weight. Inasmuch as the cylinders revolve rapidly in the air, they are air-cooled, and no other air-cooling machinery is required. The cylinders act as their own fan, and the cooling effect has been found to be perfectly satisfactory. In the automobile motors, as first developed, longitudinal ribs were cast on the cylinders, but in 1907 these were discarded, it having been found that smooth cylinders as large as 5 inches bore and 5 inches stroke cooled perfectly working in this way. Another saving of weight comes from the fact that all five cylinders work on a common crank-pin, and all ten valves are operated by one cam.

Not the least difficult part of the design was the attachment of five connecting-rods to a crank-pin 1⅜x4 inches, so that the working pressure per unit of bearing surface would not greatly exceed the limits imposed by lubrication and durability. A longitudinal section of a cylinder, connecting-rod and the crank-shaft is shown in Fig. 5. Four of the connecting-rods have narrow forked bearings encircling the crank-pin, while the fifth rod has a single bearing double the width of one fork and, of course, equaling the width of two. The exterior of these bearings or forked parts is machined truly circular, and each connecting-rod is made with an ex-

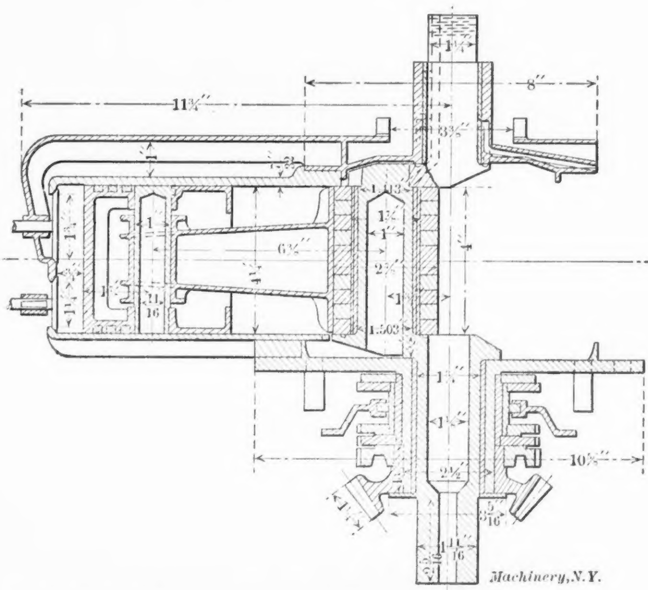


Fig. 5. Vertical Section through a Cylinder and the Crank-shaft, showing Method of attaching Connecting-rods to the Crank-pin.

tended part each side of the forked bearings which is machined to fit the exterior of the other connecting-rod forks. Inasmuch as the maximum pressures transmitted to the connecting-rod act to compress it against the crank-pin, the working bearing of each connecting-rod on the power stroke is the full length of the pin and about 60 degrees of its circumference.

Each cylinder is cast with the head and a part of the central crank case in one piece of steel of high tensile strength, each weighing only 7½ pounds. The five cylinders are bolted together and are bolted to a top aluminum flange, weighing 3 pounds, which forms the gas manifold. At the bottom the cylinders are bolted to a steel flange, which supports the valve cam and the transmission gear. These flanges have long bronze bushings, and form bearings around the vertical stationary crank-pin. The pistons are made of cast iron and weigh 2½ pounds each. The connecting-rods are made of bronze.

As before stated, the valves, ten in number, are operated by one cam. These valves have no springs to close them, but being in the heads of the cylinders and closing outwardly, they are closed by centrifugal force. The higher the speed of the motor, the greater the centrifugal force, and the greater the necessity for a strong force to close the valves quickly. Centrifugal force also puts the gas in each cylinder under pressure, which is an advantage in a high speed engine. The engine operates under the variable compression system, used for several years on the Adams-Farwell automobile motors. It consists in mechanically holding the inlet valve open for a part of the compression stroke, and closing it after a part of the gas has been blown back, and taken in by another cylinder, which at that time is under the suction stroke. The compression is relieved and the motor runs with little compression resistance when starting or running slowly. It may be gradually increased until maximum speed and power is obtained, and may be as gradually reduced when stopping the motor. Therefore, there is not the abruptness in starting or stopping, which characterizes the ordinary gasoline motor, and this is another feature of considerable importance in aeronautical work.

The wiring for the ignition system is as simple for this five-cylinder motor, as it could be for a single-cylinder motor. There is but one spark coil, one timer and contact, one primary, and one secondary current. Fig. 1, showing the top view of the motor, makes the arrangement clear. The wire is attached to a flat steel spring. This is insulated for the remainder of the timer by a fiber block. A hardened steel wheel is mounted freely on the concentric or crank end of a short shaft, which is geared to the motor, and which makes one revolution to each two-fifths revolution of the motor. A distributor for the secondary current is formed by a strip of brass on the lower edge of a fiber segment, supported by a bracket shown. A short, bare wire leads from the spark plug, on each cylinder, to a fiber insulator, near the crank case. In the top of this insulator is a screw, which, when the motor turns, passes under the distributor, but does not touch it. When the cylinder, which is to be fired passes under the distributor, the timer wheel makes contact with the springs and the secondary current passes to the spark plug of that cylinder. Each alternate cylinder is on the power stroke as it passes the dead center of the crank. There being five cylinders, the power strokes are in perfect rhythm. After the motor is started, the timer case is swung around to the left, which advances the spark to its maximum.

The same shaft that turns the timer wheel revolves the force-feed oil pump by means of a worm gear. The rectangular block shown at the top, which is clamped to the upper tube, not only forms a support to the upper end of the crank-shaft, but makes an oil tank holding one-half pint of lubricating oil. It supports the timer and oil pump, and in one end is formed a carbureter with float-feed chamber. The complete device weighs only 2½ pounds. To recapitulate the advantages claimed for the Farwell motor, for aeronautic purposes are:

Gyroscopic force, utilized to steady aeroplanes in flight; the entire motor revolves around the stationary crank-shaft, giving maximum fly-wheel effect for given total weight; the lightest motor of this power that has ever been constructed (97¼ pounds, rated at 36 H.P.); motor has no fly-wheel, no muffler, and no cooling device, other than that made by the revolving cylinders; valves close by centrifugal force, instead of springs; ten valves actuated by a single cam; simple ignition system identical with that used on single-cylinder motors of ordinary design; gas injected into the cylinder under pressure by centrifugal force; absolute freedom from unbalanced forces and vibration. The motor is built by the Adams Co., Dubuque, Iowa.

* * *

Electric welding enables certain manufacturing operations to be accomplished easily, simply, and, therefore, cheaply, which, if conventional old-time methods were used, would be very costly and difficult. Take for example the case of multiple-throw automobile crank-shafts. Every one knows how hard it is to drop forge such work satisfactorily beyond two throws in one piece, following common practice. It is made comparatively easy if electrical welding is employed as an assembling process. Four-throw and six-throw shafts are now built up by electrical welding in the rough, using single-throw or double-throw units until sufficient throws have been united. The advantage of the method has been recognized as making possible a still further advancement. If the single-throw drop forgings are rough-turned and rough planed before being electrically welded together, the finishing operations of the assembled shaft are greatly simplified and cheapened.

MAGNALIUM.

VALUABLE CHARACTERISTICS OF AN ALUMINUM ALLOY.

Magnalium is an aluminum and magnesium alloy which promises to fulfill the expectations based in the past on aluminum, but never realized on account of its softness and other unfavorable qualities, which have been overcome by the development of magnalium. For the following interesting notes on its characteristics we are indebted to Mr. Morris R. Machol, 32 Park Place, New York, who is the American agent of the Magnalium Syndicate of Berlin, Germany.

Magnalium like pure aluminum can be cast in a liquid condition. The castings can be machined about the same as brass. The machined surfaces are of a mirror-like smoothness and silvery color. Perfect screw threads can easily be cut in the metal, and bored holes can be made smooth and true. Filing it results in fine, regular, clean-cut surfaces without tearing up the metal or clogging up the file as does aluminum, and the action is accompanied by the usual typical sound which is heard when filing. Only rough or medium fine files can be used on aluminum, preventing, of course, any exact work, while magnalium will allow the use of even the finest kind of files.

Magnalium can be cast by any ordinary foundryman, the only precaution necessary being the use of *clean* graphite crucibles, and care must be taken not to increase the temperature too far above the melting point (1185 to 1250 degrees F.) as this weakens the metal. If cast in an iron chill the tensile strength is greatly increased and is at a maximum if the chill is water-cooled. Cast in dry sand, the usual quality of magnalium has a tensile strength of 18,000 to 21,000 pounds per square inch, and shows reduction of area of 3¾ per cent; cast in iron chills, 22,000 to 25,000 pounds per square inch; reduction of area, 5 to 8 per cent. The tensile strength of a quality containing a somewhat smaller percentage of aluminum equals about 34,000 pounds per square inch, but can be increased to about 42,500 pounds per square inch by proper treatment. By drawing, rolling, pressing, etc., the tensile strength obtained by quick cooling is still further increased. Wire drawn from one quality of the alloy has a tensile strength of 41,000 pounds and 10 per cent reduction of area, while it will stand 53,000 pounds if the raw material has been forged before drawing. Soft rolled sheets of alloy "Z" have a tensile strength of 42,000 pounds and 15 per cent reduction of area; hard rolled sheets, about 52,000 pounds and 3 per cent reduction of area.

Magnalium containing less than a certain percentage of aluminum cannot be rolled but can readily be drawn. The tensile strength of a drawn bar tested was 60,000 pounds, and that of a tube, 74,000 pounds per square inch.

Another advantage of magnalium is that it is extremely close grained, so that the polishing can be done without previous treatment. Furthermore, in lathe work the tool speed can be twice as great as with aluminum, thus making a saving in labor. Transparent or colored lacquers can be readily applied; polishing, etching, engraving, etc., can be easily done.

Pure aluminum being soft, can be cut with a knife like zinc or lead, while magnalium is hard. Some magnalium alloys, however, are very ductile and can be forged, rolled, drawn, etc., as intimated in the foregoing, sharing all advantages of aluminum in this direction. Annealed magnalium "Z" is so ductile that it can be rolled or beaten like silver. The elasticity of cast or annealed magnalium is small, but in the forged, hard-rolled or drawn material it is much greater. It attains and maintains a high polish and shows excellent resistance to atmospheric conditions. The color of magnalium is silvery white in contrast to the grayish aluminum. Besides all this, magnalium has the advantage that its specific gravity is less than that of aluminum. While the specific gravity of pure aluminum is 2.64, magnalium shows 2.4 to 2.57, according to the percentage of alloy. Other aluminum alloys have a greater specific gravity than aluminum, the most of them being between 3 and 4.

Magnalium has no odor. It resists oxidation better than aluminum or any other light metals and is almost unaffected by dry or damp air, water, gaseous ammonia, carbonic acid, sulphureted hydrogen and most organic acids. It is very slowly affected by saltpeter or sulphuric acid and more rapidly by alkalies or strong alkaline solutions. Salt water attacks magnalium slightly, and where exposed to sea water the metal should be lacquered, which will protect it so that it will give excellent satisfaction.

Magnalium shows almost no magnetic influences, but its electric and thermal conductivity is about 56 per cent of that of pure copper. The specific heat of magnalium is 0.2185.

Magnalium, especially alloys "X" and "Y," can be forged with good results most easily by heating the metal and then working about the same as Swedish steel. The metal must not glow red, but must be hot enough to char a piece of wood. Of course, the casting should be clean before forging to avoid cracks in the metal.

The great ductility of magnalium, especially alloy "Z," makes it possible to produce plates of any thickness. The ingot is first heated to between 570 and 660 degrees F. and rolled so that the reduction at the first pass is about 20 per cent. Then the plate is again heated. After the first two passes the plate is turned 90 degrees and passed through the finishing rolls until it reaches the required thickness. As magnalium rapidly loses its ductility in rolling, it has to be annealed repeatedly.

Magnalium should be annealed in a muffled furnace in order to keep the flame and gases away from the metal. The annealing furnace must be kept at an even heat. The metal must appear dark red and char a pine wood stick so that carbon particles separate from it. To anneal plates does not require as high a temperature. If plates are chilled in cold water, they will be very tough and ductile. The thinner the plates, the lower should be the temperature of the annealing furnace. Plates of less than 0.01 inch thickness can be heated in boiling oil or water and allowed to cool slowly. If the magnalium is gradually heated to a temperature of less than 750 degrees F. and slowly cooled, the metal gets so hard and elastic that it can be worked into springs.

Magnalium is a very ductile metal and in this respect is only surpassed by gold, silver, platinum and copper. When drawing, the diameter of the cast ingot should be reduced very slowly at first. Best results are obtained if the ingot is forged before drawing. Perfectly smooth wire as fine as silk threads has been made with astonishing tensile strength. Tubes made from plates or from cast hollow pieces are treated in exactly the same way as rods, namely annealed repeatedly, chilled and afterwards drawn cold over a mandrel.

Magnalium is remarkable inasmuch as that it can be tooled at high speed, about like steel. Screw threads of length can be easily and cleanly cut. The tools have to be very sharp and the surfaces (both metal and tools) must be kept lubricated with either kerosene, turpentine, paraffin, benzine, vaseline, soap-water or even clear cold water. Excellent surfaces will result and perfect screw threads or holes will be obtained. To cut magnalium, a fine-toothed saw, lubricated with kerosene, is recommended. Magnalium can be punched, drop-forged and pressed without any difficulty—about the same as silver, brass or steel plate—provided that it has been well annealed.

Weight for weight, magnalium is stronger than Siemens-Martin steel with 2 per cent aluminum alloy. This steel has an ultimate tensile strength of about 114,000 pounds per square inch. Magnalium "Z" is rated at 52,200 pounds per square inch. Dividing each by its specific gravity yields 14,400 and 20,800, or nearly 50 per cent advantage of strength for the same weight in favor of magnalium. The value of the new alloy for aeroplanes, automobiles, army equipment and many other uses in which cost is not so important as lightness, is quite apparent. The price per pound is about two times that of aluminum.

* * *

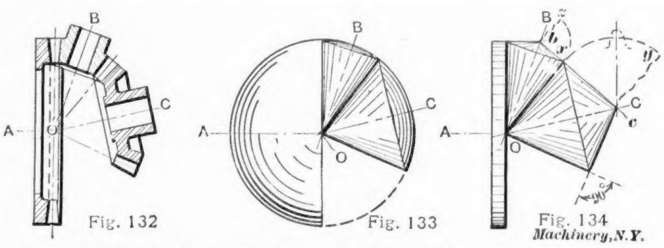
An advantageous system for lighting at the milling machines is in use in the Kearney & Trecker Co.'s shops, Milwaukee, Wisconsin. A small bracket of cast iron is screwed to the top of the milling machine at the front end, over the bearing for the overhanging arm, and into this is screwed a piece of ordinary Almond tubing, through which the wire is carried. This gives a very satisfactory flexible arrangement, and permits the light to be brought into the best position.

GEAR-CUTTING MACHINERY—7.

RALPH E. FLANDERS.*

MACHINES FOR FORMING THE TEETH OF BEVEL GEARS.

In studying methods and machines for cutting the teeth of bevel gears, we come to the most fascinating branch of the whole subject which we have been considering. It will be impossible in the comparatively short space we are able to devote to the subject to do more than give the bare outlines of the ingenious mechanisms which have been devised for this work. Almost any one of the machines we describe, operating on the templet or the molding-generating principles, would



Figs. 132, 133, 134. Illustrating the Spherical Basis of the Bevel Gear, and Tredgold's Approximation for Developing the Outlines of the Teeth on a Plane Surface.

require several pages and many illustrations to explain the details of its construction. We can, however, in the comparatively short descriptions here given, get an understanding of the principles of operation of each of them. This will best be done by analyzing the various principles of action and methods of operation applicable to the cutting of bevel gear teeth, as was done for spur gears in the introduction of this series of articles, following the same classification there given, but making the necessary changes in the mechanisms shown in Figs. 1 to 10 to fit them for the work of cutting bevel gears instead of spur gears.

The changes required in the spur gear cutting devices to adapt them for cutting bevel gears, made necessary by the difference in the nature of the two forms of gearing, are explained in Figs. 132, 133, and 134. The action of a pair of mating spur gears may be seen and studied on the plane perpendicular to their axes. To be understood correctly, the action of bevel gearing must be observed on a spherical surface. In Fig. 132 are shown three bevel gears with axes *OA*, *OB*, and *OC*. The bevel gear on axis *OA* is of the form known as the "crown gear." It is practically a rack bent in a circle about center *O*. Pinion *OB* and gear *OC* are familiar types of bevel gears. In Fig 133 are shown the pitch surfaces of the gears in the preceding figure. It will be seen in that figure that the pitch lines of the gear on the axis *OC*, for instance, converge at the center *O*. These pitch lines represent a conical pitch surface which is shown cut out from a sphere on axis *OC* in Fig. 133. In a similar way the cone about axis *OB* represents the pitch surface of the pinion in Fig. 132, while the plane face of the hemisphere at the left of Fig. 133 is the pitch surface of the crown gear of the preceding figure. If we wish to draw accurate representations of the teeth of the bevel gears in Fig. 132, in order to study their action in the same way that we can when drawing the teeth of spur gears on the plane surface of the drawing board, we would have to draw them on surfaces of the sphere from which the pitch cones in Fig. 133 are cut. The pitch circles, etc., of the various gears would be struck from centers located at the points where the various axes *OA*, *OB* and *OC* break through the surface of the sphere. Except for the different surfaces

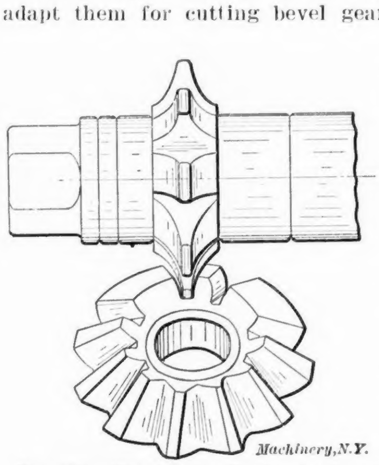


Fig. 135. Shaping the Teeth of a Bevel Gear by the Formed Cutter Process.

* Associate Editor of MACHINERY.

on which the drawing would be done, the procedure would be identical with that for spur gears. It should be noted that straight lines on spherical surfaces are represented by great circles—that is to say, by the intersection with the surface of planes passing through the center of the sphere.

Owing to the impracticability of the sphere as a drawing-board, an approximate process, known as "Tredgold's," is usually followed for laying out the teeth of bevel gears approximately. This is shown in Fig. 134 applied to the same case as in the two preceding figures. The conical pitch surfaces vanishing at the center *O* are identical with those in Fig. 133, as is also the plain circular face of the crown gear. For the bevel gear and pinion, however, the teeth are supposed to be drawn and the action studied on surfaces of cones complementary to the pitch cones—that is, on the cones with apexes at *c* and *b*. The surface of these cones can be developed on a flat piece of paper, as shown for that on axis *OC* in Fig. 134, in which case the pitch line becomes *xy*, as there illustrated. Teeth drawn on this pitch line, as for a spur gear, may be laid out on the conical surface and used as the outlines of bevel gear teeth. The difference in the shape of tooth obtained under the same system as the two methods shown in Figs. 133 and 134, is so slight as to be negligible, except perhaps, in gears having very few teeth. Whatever the method pursued for laying out or studying the action, all

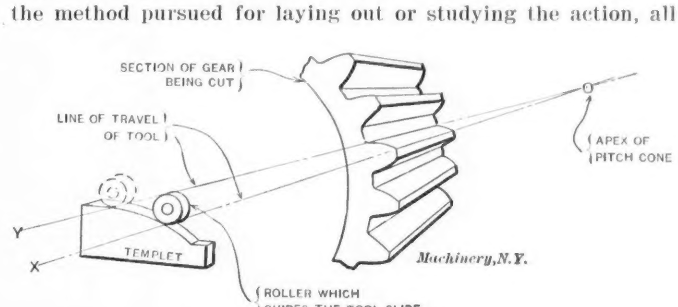


Fig. 136. Diagram illustrating the Templet Principle for Forming the Teeth of Bevel Gears.

the elements of which the teeth are formed consist of straight lines which meet at the center *O* of the pitch cones; consequently the teeth grow small toward the inner end, vanishing at the center if they are carried that far.

Five Principles of Action.

All of the five principles of action on which spur gear teeth may be formed (the formed tool, the templet, the odontographic, the describing-generating and the molding-generating principles) may be also applied to the cutting of bevel gears, though the describing-generating principle has never been so used, as far as the author's knowledge goes, so we will not give any time to its consideration.

The Formed Tool Principle: The use of this principle is illustrated in Fig. 135, where we have a bevel gear blank set

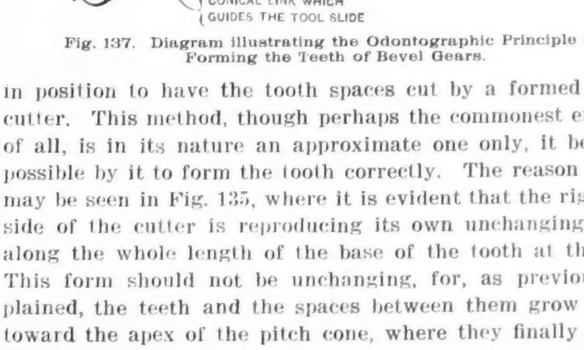


Fig. 137. Diagram illustrating the Odontographic Principle for Forming the Teeth of Bevel Gears.

in position to have the tooth spaces cut by a formed milling cutter. This method, though perhaps the commonest employed of all, is in its nature an approximate one only, it being impossible by it to form the tooth correctly. The reason for this may be seen in Fig. 135, where it is evident that the right-hand side of the cutter is reproducing its own unchanging outline along the whole length of the base of the tooth at the right. This form should not be unchanging, for, as previously explained, the teeth and the spaces between them grow smaller toward the apex of the pitch cone, where they finally vanish;

so it is evident that the outline of a tooth at the small end should be the same as that at the large end, but on a smaller scale—not a portion of the exact outline at the large end, as produced by the formed tool process and as shown in the figure. To make this error as small as possible, it is customary to use a cutter which gives the proper shape at the large end, and set the blank so that the tooth is cut to the proper thickness at the small end. This leaves the top of the tooth at the

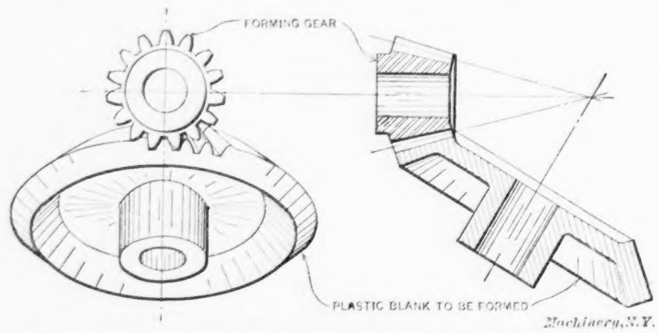


Fig. 138. The Impression Operation, applied to forming the Teeth of a Bevel Gear by the Molding-Generating Process.

small end too thick, an error which is often remedied by filing. Of course, the principle is the same with the formed planer or shaper tool as with the formed milling cutter, and the errors involved in the process are also identical. It is evident that but one side of the tooth space can be cut at a time, so that at least two cuts around will have to be taken.

The Templet Principle: This principle is illustrated in Fig. 136, in skeleton form only. A former is used which has the same outline as would the tooth of the gear being cut, if the latter were extended as far from the apex of the pitch cone as the position in which the former is placed. The tool is carried by a slide which reciprocates it back and forth along the length of the tooth in a line of direction (OX, OY, etc.) which passes through the apex O of the pitch cone. This slide may be swiveled in any direction and in any plane about this apex, and its outer end is supported by the roller on the former. With this arrangement, in the case shown, as the slide is

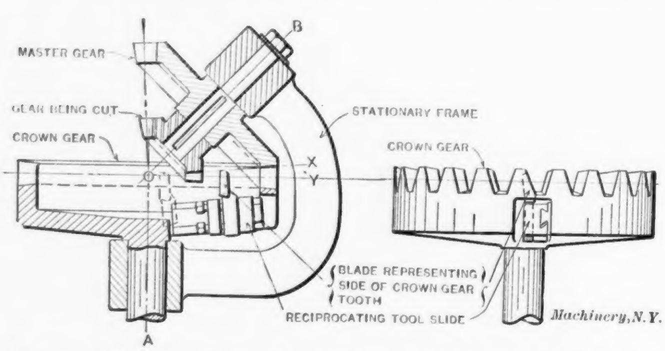


Fig. 139. Model illustrating the Shaping or Planing Operation, applied to the Molding-Generating Principle of forming the Teeth of Bevel Gears.

swiveled inward about the apex, the roll runs up on the former, raising the slide and the tool so as to reproduce on the proper scale the outline of the former on the tooth being cut. Since the movement of the tool is always toward the apex of the pitch cone, the elements of tooth vanish at this point, and the outlines are similar at all sections of the tooth, though with a gradually decreasing scale as the apex is approached—all as required for correct bevel gearing.

The arrangement thus shown diagrammatically is modified in various ways in different machines, but the movement imparted to the tool in relation to the work is the same in all cases where the templet principle is employed, no matter what the connection between the former and the tool may be.

The Odontographic Principle: As explained for spur gears in Fig. 3, it is often possible to approximate the exact curves required for the teeth of gears by mechanisms which make use of circular arcs or other easily generated curves. In Fig. 137 is shown in diagrammatic form an arrangement for obtaining, by means of link work, a close approximation to the exact form of an involute outline, such as might be produced by the templet in Fig. 136, for instance. This true involute outline may be very closely approximated by a circle drawn on the surface of a sphere. To give this required circular movement to the point of the tool, the slide on which the tool reciprocates may be constrained by a link as shown, pivoted at the base to the frame of the machine, and at the upper end to the slide. The axes of these pivots should pass through the apex of the pitch cone, as required by the spherical nature of the bevel gear. This link work (which is thus of the "conical" type) if properly proportioned and located, will guide the tool slide and the tool point in very nearly the same way as a properly constructed templet, used as shown in Fig. 136.

The Molding-Generating Principle: The counterpart of the spur gear process shown in Fig 5 is illustrated for the bevel gears in Fig. 138. Here a correctly formed gear is being rotated in the proper position and in the proper ratio with a plastic blank. This operation, as in the case of the spur gear, forms teeth in the plastic blank which are properly

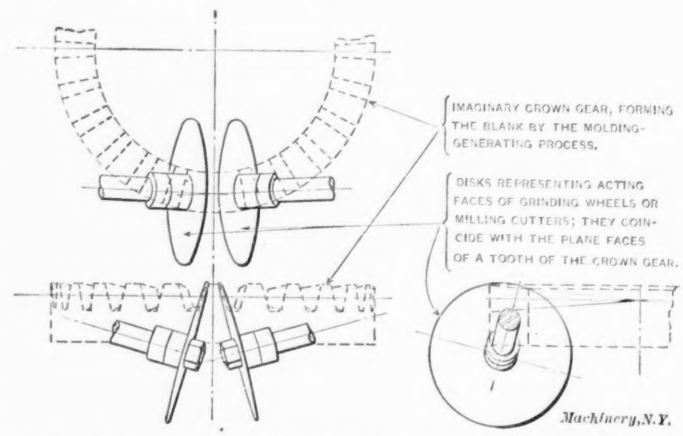


Fig. 140. Diagram suggesting the Arrangement of Milling Cutters or Grinding Wheels for Forming the Teeth of Bevel Gears by the Molding-Generating Process.

shaped to mesh with the forming gear or with any other gear of the same series. Fig. 6 has no possible counterpart in the cutting of bevel gears.

Four Methods of Operation.

By Impression: The same four methods of operation as for spur gears may be applied to the molding-generating principle, and quite generally to the other principles as well. Instead of using for illustration a rack as the generating member, we will have to use its bevel gear counterpart, the crown gear shown in Fig. 132. The impression method would simply

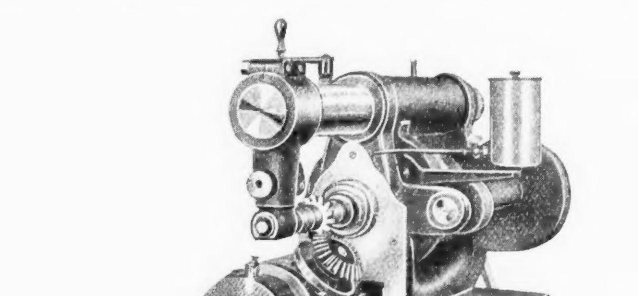


Fig. 141. Cutting Bevel Gear Teeth on a Milling Machine by the Formed Cutter Method.

consist of rolling the crown gear on axis OA and the pinion on axis OB together, when, if the latter were formed of a plastic material, the teeth of the crown gear would produce in its smaller mate corresponding tooth spaces and teeth of the proper shape.

By Shaping or Planing: There is but one form of tooth to which the planing operation of molding-generating is adapted. This is the form in which the crown gear has teeth with plane sides, which may be cut with a straight-sided tool. If

the drawing of an involute rack were wrapped around the periphery of the disk in Fig. 134, about axis *AO*, and the tooth outlines thus determined used in teeth vanishing at *O*, in the plane of the pitch line, the resulting crown gear would be of this type. In other words, it is Tredgold's approximation of the involute system. In Fig. 139 such a crown gear is shown combined with a simple mechanism for making use of the planing or shaping operation in the molding-generating process. The gear being cut is keyed on a loosely revolving spindle, to which is also keyed a master gear, formed on the same pitch cone and having, in this case, the same number of teeth. This spindle is so set in relation to the axis about which the crown gear revolves, that the master gear and

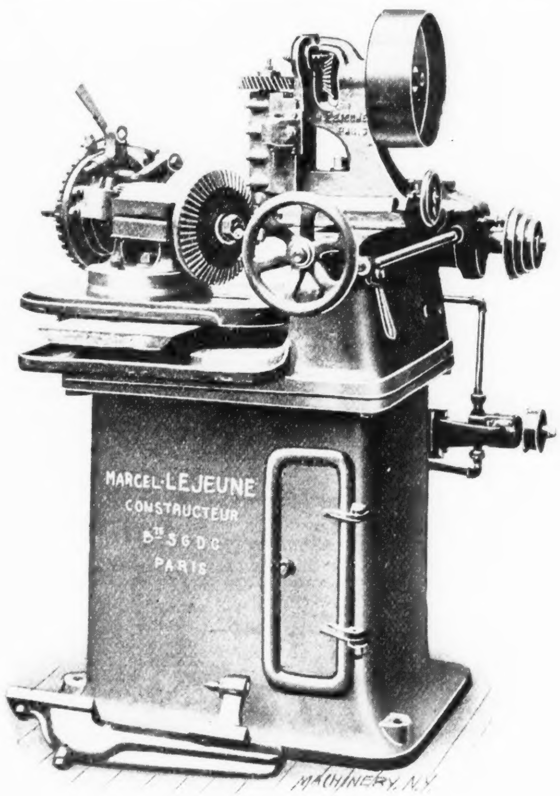


Fig 142. A Special Milling Machine for Cutting Bevel Gear Teeth.

the crown gear mesh together properly, the crown gear being of the required pitch, and having the proper number and shape of teeth for this action. If now the crown gear be rocked about its axis, the master gear will also rock with it, carrying the gear being cut.

The blade is set, as shown in the view at the right, so that its cutting edge coincides with the plane of one of the teeth of the crown gear, and being held in a slide which guides it in such a way that it moves in this plane, and so that its point follows the line *OX*, radiating from the apex *O* of the pitch cones. The tool will evidently represent the side of the tooth of an imaginary crown gear, which is adapted to mesh properly with any bevel gear such as that shown being cut, keyed to the master gear and having the same pitch cone shape and number of teeth.

If, with the mechanism so arranged, the crown gear be rotated so as to start the cut at one side of a tooth of the work (which should be first roughly cut to size) the continued rotation of the crown gear will roll the master gear in such a way that the reciprocating blade (representing the side of an imaginary crown tooth meshing with the work) will shape the side of the tooth being cut to the proper form, by the molding-generating process, on the same principle as shown in Fig. 138.

This arrangement, of course, is not a practical working machine as shown, since there is no provision for making it universal for cutting bevel gears of other pitch cone angles and numbers of teeth, or for indexing the work with relation to the master gear to cut the remaining teeth of the work shown in place. Arranged as shown, however, the machine will cut any gear within its range, of the same pitch cone angle and number of teeth as the master gear. To cut a different number of teeth it would only be necessary to alter angle *XOY*, as required, setting the slide at a greater angle for fewer and larger teeth, or at a less angle for more and smaller teeth.

This principle will be found applied in this and in modified forms in machines we will describe later. One of the modifications which will be seen is equivalent to making the crown gear in Fig. 139 stationary, and swinging the frame around it about axis *OA*, thus rolling the master gear and the work in the same relation to the tool as when the frame is stationary and the crown gear is revolved, in the way we have just described. Still another possible modification would consist in holding the master gear and work still, while the frame is swung about axis *OB*. In this case the crown gear would roll on the master gear, rocking the tool slide in such a way as to give the required movement. It is not possible to form a tooth space complete with a single tool, as shown for spur gears, at T_1 in Fig. 8, without cutting the tooth space too deep at the outside end. A separate blade has to be used for each side of the space or of the tooth.

By Milling, and by Grinding or Abrasion: Milling cutters or grinding wheels may be used to represent the space of the tooth, as they represent the rack tooth for spur gears in Figs 9 and 10. In Fig. 140 is shown diagrammatically an arrangement by which two cutters or grinding wheels may be made to represent the two sides of a tooth in such a way that by them a tooth space may be finished complete in the gear to be cut in a mechanism similar to that in Fig. 139, but without requiring the reciprocating movement. The same difficulty arises as in spur gears, of the center of the tooth being cut in deeper than the ends, owing to the circular form of the cutter. This, however, makes no change in the action of the finished gear.

The variety of applications for these various principles and methods of operation is fully as great in bevel gears as in

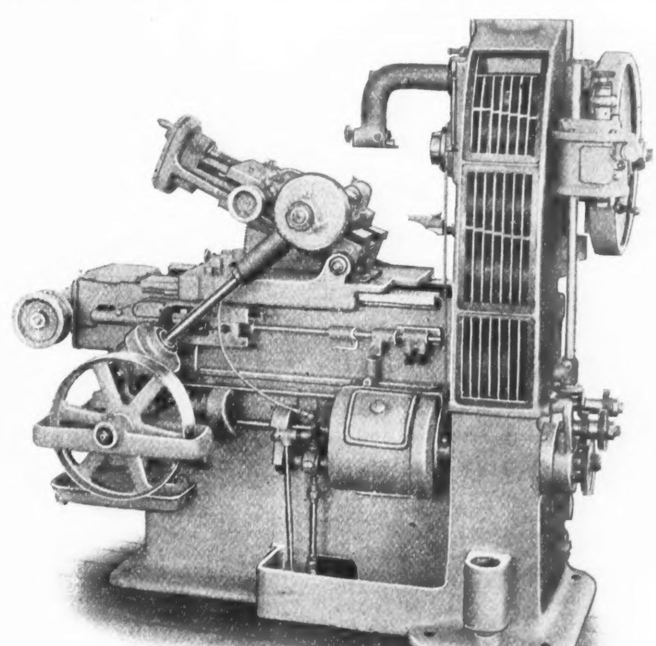


Fig. 143. Brown & Sharpe Automatic Spur and Bevel Gear Cutter, as set up for Cutting Teeth of the latter Form.

spur gears, and the machines in which they are incorporated apply these principles and methods in an even more ingenious fashion.

Machines using Formed Milling Cutters for Shaping the Teeth of Bevel Gears.

One of the most commonly used machines employing the formed tool process is the ordinary milling machine. An example of the use of the Cincinnati miller for this purpose is shown in Fig. 141. The work is held on an arbor carried by the spindle of the universal head, by which the blank is indexed for the required number of teeth. The head is set to the proper angle to make the bottom of the tooth space horizontal. As explained in the paragraph describing Fig. 135, it

is possible to cut but one side of a tooth space at a time, if teeth of even approximate accuracy are desired. For this reason, and to obtain as nearly a correct form of tooth as possible, the side of the tooth to be cut is moved away from the cutter horizontally and then the work spindle is revolved to bring it up to it again, the amount of "set-over" and "rolling" being adjusted by judgment and by "cut-and-try," to give the best results. Instructions for doing this have recently been published in MACHINERY.*

The automatic attachment built by Ludwig, Loewe & Co., and shown in Fig. 14, is also adapted to the cutting of bevel gears in the milling machine, which it renders automatic,

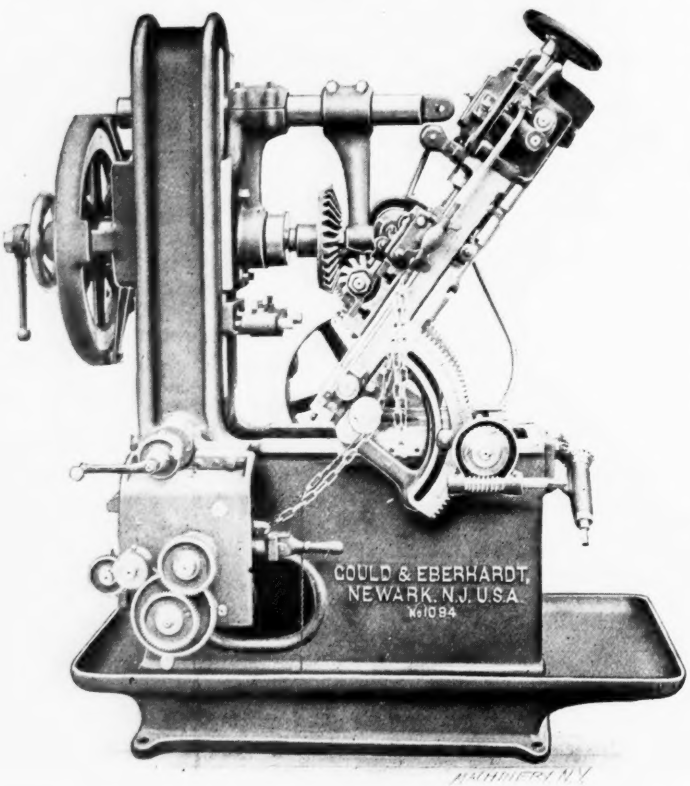


Fig. 144. Cutting a Bevel Gear on the Gould & Eberhardt Automatic Machine of the Orthodox Type.

doing the work under the same conditions as the orthodox machine shown in Figs. 143 and 144.

The dividing head of the milling machine may also be used on the shaper table, for indexing the work and setting it to the proper angle when cutting the teeth with a shaper tool having a blade formed to the proper outline. The necessary set-over and rolling movements required to reproduce an approximation to the correct form are exactly identical with those necessary for the milling machine. The shaping process may be used for odd jobs where no formed cutter is available.

In Fig. 142 is shown a special machine which is identical in operation with the milling machine when used as shown in Fig. 141. Being built, however, especially for the work of cutting bevel gears, it is of simpler construction and less expensive. The bed of the machine carries sliding ways at the right, on which is mounted a knee on the face of which the cutter spindle is vertically adjustable. The latter is driven, through the twisted and bevel gearing shown, from a wide-faced pulley of large diameter. The knee is not mounted directly on the slide but is carried by an intermediate saddle along which it is adjustable in and out for the depth of cut. The feed is provided with an automatic stop, but is returned by hand. The work is mounted on a spindle set in a head, which may be clamped at the proper cutting angle on the base by which it is supported. This base may be adjusted toward or away from the cutter as well as parallel with the movement of the latter, to approximately the position required. The work is indexed by a notched plate operated by hand. The index locking pin is itself carried by an arm which may be swung about the axis of the work by a worm and worm-wheel adjustment to give the required rolling movement, independently of the indexing for correcting the shape of the teeth. What corresponds to the cross movement given the blank in the milling machine is effected here by the vertical adjustment of the cutter spindle on the face of the knee. Provision is made for making both of these adjustments positively and quickly. This machine is built by Etablissements Marcel Lejeune, 93 Rue D'Angouleme, Paris.

Another favorite way of using the formed cutter principle for cutting the teeth of gears employs a modification of the orthodox automatic gear-cutting machine, such as previously shown in Figs. 21 to 28 inclusive. When this is done, one side of the tooth can be finished clear around without attention from the operator, the cutter slide feeding up, returning, and the work indexing, as for spur gears. The cutter has to be set out of center with the blank and the latter rotated, to approximate the correct form, as with the machines previously described. After going around one side of the tooth, this adjustment has to be reversed to complete the other side, so that two operations are necessary. Fig. 143 shows the Brown & Sharpe gear-cutting machine as provided with the angular cutter slide adjustment for bevel gears, and Fig. 144 shows a Gould & Eberhardt machine arranged for the same work. Probably a greater proportion of the bevel gears made are cut on machines of this kind than in any other way. For slow running gears, the approximation, especially if the teeth are afterward filed, may be made close enough to be correct for all practical purposes. For large, high-speed gears to transmit power, one of the planing processes to be described later should be used.

In Fig. 145 is shown still another method of adapting the orthodox gear-cutting machine to the work of cutting bevel gears. The machine shown in this case is that built by the

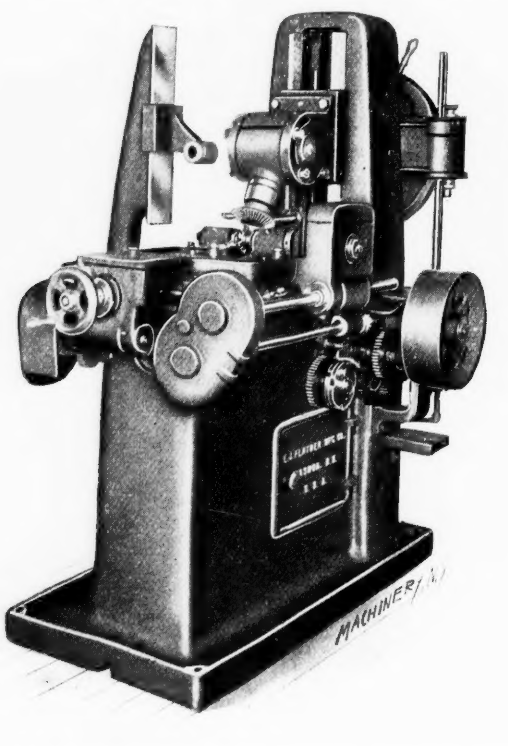


Fig. 145. An Attachment to the Flather Automatic Spur Gear Cutter for the Cutting of Bevel Gears.

E. J. Flather Mfg. Co., of Nashua, N. H., and illustrated in Fig. 23.* The attachment consists of a supplementary work spindle connected with the main work spindle by bevel gearing in such a way that it may be adjusted to any angle, thus making it unnecessary to complicate the cutter slide and feeding mechanism. The attachment is suitable for work of small diameter, and may be applied to machines not originally designed for cutting bevel gears.

The automatic idea has been carried still further in a machine developed a few years ago by the Brown & Sharpe Mfg. Co., of Providence, R. I., for cutting bevel gears for chainless bicycles. These gears were to be made in enormous quantities,

* See article "Cutting Bevel Gears with a Rotary Cutter," in the October, 1907, issue of MACHINERY.

* See "New Machinery and Tools" in the December, 1907, issue of MACHINERY.

so that the time lost in the side adjustment and the rolling of the work to bring the blank and cutter into position for cutting the other side of the teeth, after one side had been completed, consumed sufficient time to make the elimination of the operation profitable. The machine shown in Fig. 146 was therefore devised to first feed the cutter through, with the cutter and work set properly for finishing one side of the tooth;

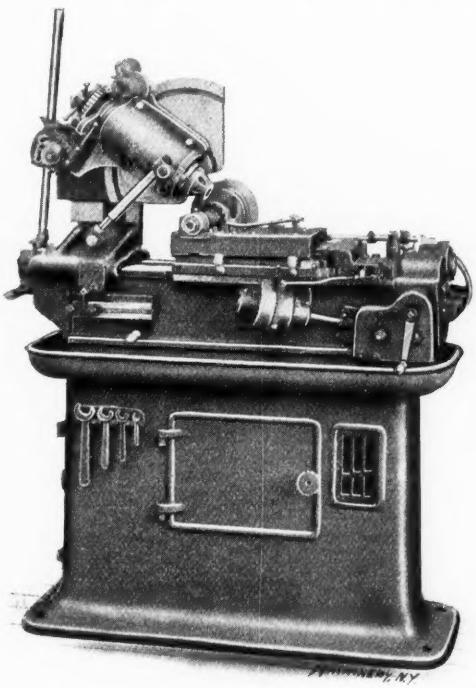


Fig. 146. A Special Bevel Gear Cutting Machine in which provision is made for Shifting the Line of Travel of the Cutter; both Sides of the Teeth are finished automatically.

when the cutter had passed through the work, the slide on which it was mounted was shifted to a different angular location, so that when it was fed backward to its starting position the return cut operated on the opposite side of the tooth space, under conditions which finished it to the desired form. This change in angular position of the tool slide was so adjusted as to be equivalent to the rolling of the blank and the sidewise movement of the cutter or work, required in cutting bevel gears in the milling machine or automatic gear-cutter.

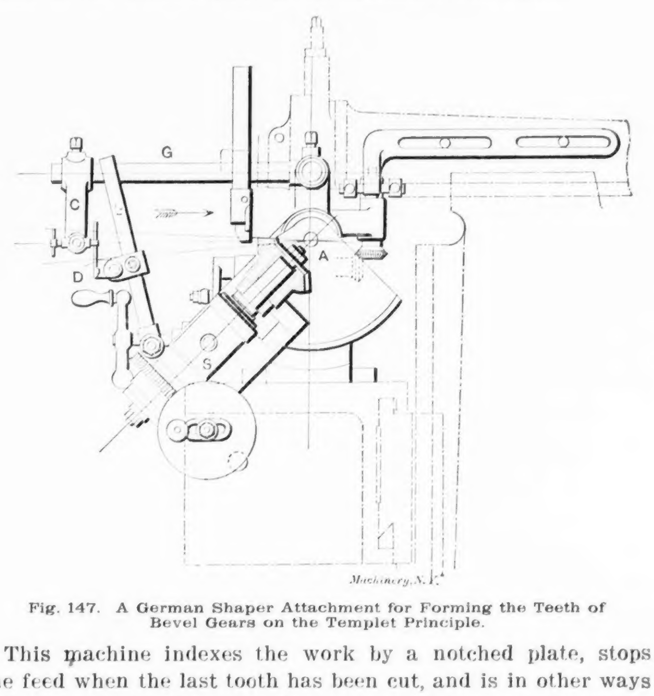


Fig. 147. A German Shaper Attachment for Forming the Teeth of Bevel Gears on the Templet Principle.

This machine indexes the work by a notched plate, stops the feed when the last tooth has been cut, and is in other ways adapted to the rapid manufacturing of gears in large quantities. The gears are afterwards finished by molding-generating process to be described later, in which the inaccuracies inherent in the formed tool principle are smoothed out. Of course, its usefulness is not limited to the bicycle field for which it was first designed.

Attachments for Forming the Teeth of Bevel Gears by the Templet Principle.

The templet principle has found a much wider commercial application for cutting bevel gears than for cutting spur gears. This is due to the fact that the formed tool method, as we have seen, is not suited to producing theoretically accurate teeth in the bevel type of gear as it does in the case of the spur, since it does not give to the teeth an outline at the small end similar to that at the large end. Since the templet process is the least complicated way of forming a tooth similar in outline from one end to the other (in other words, one whose elements vanish at the apex of the pitch cone), a number of very successful commercial machines have been built involving this principle. The first cases we will consider, however, are not complete machines, but attachments to the shaper.

In Fig. 147 is shown an attachment built by the Act.-Ges. für Schmirgel-u. Maschinen-Fabrikation, Bockenheim-Frankfurt am Main.* This is mounted on the shaper table so that the angularly adjustable head which carries the work spindle overhangs the side. The work spindle is indexed with worm and worm-wheel and index plate as in the case of the milling machine dividing head. This indexing mechanism is attached to a quill which is journaled in the work spindle head. It has adjustably mounted on its outer end a bar *B*, to which a holder is attached for supporting the templet *D*. An outer arm *C*, supported from the frame of the attachment by a

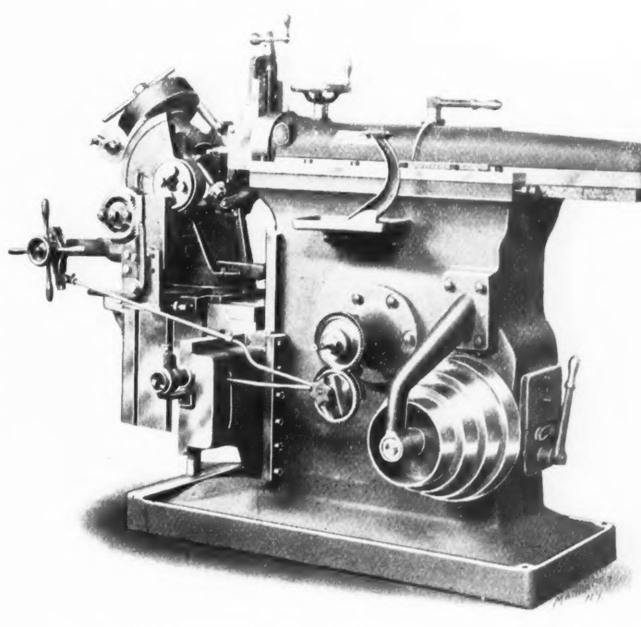


Fig. 148. An American Shaper Attachment employing a Templet for Controlling the Shape of the Bevel Gear Tooth produced.

bar *G*, carries a roll which is adapted to engage with the edges of templet *D*. The blank, in feeding, is swung up into the tool about center *A*. This swinging movement is operated by a worm and worm-wheel sector controlled by a ratchet feed. As the work is thus gradually fed up into the tool, the action of the roll on the templet will rock bar *B*, and the quill and index motion attached to it, thus swinging the work in such a way as to reproduce the outline of the templet on the outside of the tooth. The action is thus identical in its effects with that in Fig. 136, though the templet is used to control the work instead of controlling the tool.

The attachment shown clamped to the shaper table in Fig. 148 is the invention of Mr. Fred Mill, 704 Prytania Ave., Hamilton, Ohio. The design of the attachment will best be understood from the line elevations in Fig. 149. The work spindle is carried in a head *B*, which is swung on horizontal trunnions *A* in housing *C*. This housing is held by semi-circular gibs to the circular base-plate *D*, so that it may be swung about a vertical axis. The feed rod *E*, operated by the regular feed movement of the shaper, is connected through a ratchet and hand-wheel with a worm and worm gear *F*, connected by spur gear segments with the spindle head *B* in

* See article "Two German Bevel Gear Shaping Attachments" in the May, 1907, issue of MACHINERY.

such a way as to swing it about its horizontal trunnions A, and thus feed the blank up into the tool.

On the base-plate D to which the housing is gibbed, is attached a holder G to which the former or templet is fastened. The roll which bears on this templet is held in a roller slide J, which is connected with the segment gears which swing the head in such a way that, as the blank is fed upward into the work, the roller slide is fed downward, carrying the roller along the face of the templet. Since the roll and roller slide are supported by the housing C, the templet moves the housing about its vertical axis, in conjunction with the swinging of the head about its horizontal axis, so as to produce the proper shape of tooth. The roll is held in contact with the templet by lever K, one end of which carries a weight, while the other bears on the roll stud. For shaping the other sides of the teeth, the templet is fastened on the other side of holder G, and the bent lever K is reversed so as to press the roll against the templet in its new position. A stop is provided which releases the automatic feed and quickly returns the head, so that the tool clears the work, as soon as the cut has been made to the proper depth. We understand that Mr. Mill is designing an automatic machine, operating on the same principle.

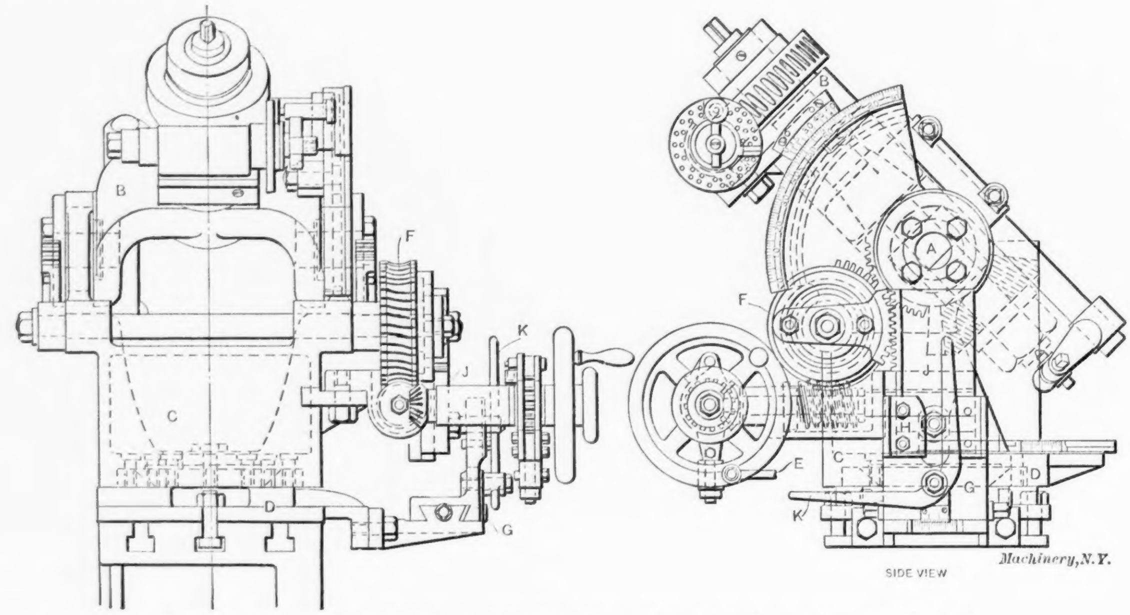


Fig. 149. Rear and Side Elevations of the Bevel Gear Shaper Attachment shown in Fig. 148.

In Fig. 150 is shown a German bevel gear shaping attachment, the invention of Prof. Moritz Kroll of the Government Trade School of Pilsen. This device is also designed to be mounted on the shaper table. It has a base-plate to which are attached two standards, F and F_2, having bearings for the trunnions on head B, which may be adjusted about these trunnions to the desired cutting angle, by means of a worm, and worm sector E, fast to F_2. The work is divided by the index plate and adjustable crank shown, operating a worm meshing with the index worm-wheel on the rear end of the work spindle A. This index mechanism is supported on an arm, whose lower forked end is seen at I. The contact points on either side of this arm, as desired, may be made to bear under spring pressure on cam M, which is pinned to gear Q, in mesh with gear D, which is in turn keyed to the shaft C, carrying the worm engaging with sector E. All this mechanism is mounted on swinging head B, excepting E, which is pinned to standard F_2. From this it will be seen that the work may be swung up into the shaper tool about the trunnions on head B by operating shaft C.

As the work is thus swung upward, gear Q is revolved, and with it cam or templet M, which rocks the lower end of lever I, and with it, the work. Templet M is so shaped that this rocking movement, in conjunction with the upward swinging of the blank, causes the point of the tool in the shaper to produce the required outline of tooth. In this, as in the previous cases, the point of the tool is set to travel along a line which, if produced, would meet the intersection of the axis of the work spindle and the axis of the trunnions, about which the head rocks. It is possible, by providing suitable change gears between cam M and worm shaft C in place of the fixed gears shown, to use the same cam or templet M for cutting a large range of gears, it not being necessary in that case to have one for each tooth used. The principle which makes this possible was explained in a description of this attachment, previously published in MACHINERY.*

Machines for Shaping or Planing the Teeth of Bevel Gears by the Templet Principle.

In this country the templet principle is represented commercially by a single machine, that built in various sizes and designs by the Gleason Works, of Rochester, N. Y. This machine is illustrated in Fig. 151. The tool is carried by a holder reciprocated by an adjustable, quick-return crank motion. The slide which carries this tool-holder may be swung in a vertical plane about the horizontal axis on which it is pivoted to the head, which carries the whole mechanism of tool-holder, slide, crank, driving gearing, etc. This head, in turn, may be swung in a vertical axis about a pivot in the bed. The circular ways which guide this movement are easily seen in the illustration. The intersection of the vertical and horizontal axes of adjustment (which takes place in mid air in front of the tool slide) is the point O in Fig. 136, where the templet principle is shown in diagrammatic form. The apex of the pitch cone of the bevel gear must be brought to this point O. The blank is mounted on a spindle carried by a head which is adjustable in and out on the top of the

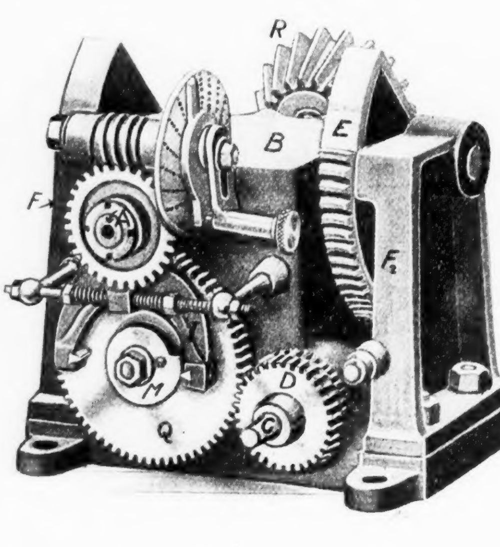


Fig. 150. Shaper Attachment devised by Professor Kroll, in which a Circular Templet is used for Forming the Teeth of Bevel Gears.

* See article "Two German Bevel Gear Shaping Attachments" in the May, 1907, issue of MACHINERY.

bed of the machine so that the apex of the cone of the gear may be brought to this point by means of the gages which are a part of the equipment of the machine. The work spindle is provided with an indexing mechanism, which operates automatically, as do all the other functions of the machine.

Three templets are used, mounted in a holder attached to the front of the bed, on the opposite side from that shown. The first of these templets is for "stocking" or roughing out the tooth spaces. It is simply a horizontal straight-edge on which rests a roller, attached to the outer end of the slide on which the tool-holder reciprocates. With the work and tool set properly, the whole tool-carrying head is swiveled about the vertical axis, feeding in at each stroke of the blade deeper and deeper, until the space has been properly roughed out. After each tooth space has been gashed in this fashion, the templet holder is revolved to bring one of the formed templets into position, and a tool is set in the holder so that its point bears the same relation to the shape of the tooth desired as the cam roll does to the templet. The head is again fed in by swinging it around its vertical axis, during which movement the roll runs up on the stationary templet, swinging the tool about its horizontal axis in such a way as to duplicate the desired form on the tooth of the gear. One side of each tooth being thus shaped entirely around, the holder is again revolved to bring the third templet into position. This has a reverse form from the preceding one adapted to cutting the other side of the tooth. A tool with a cutting point facing the other way being inserted in the holder, each tooth of the gear has its second side formed automatically, as before, completing the gear.

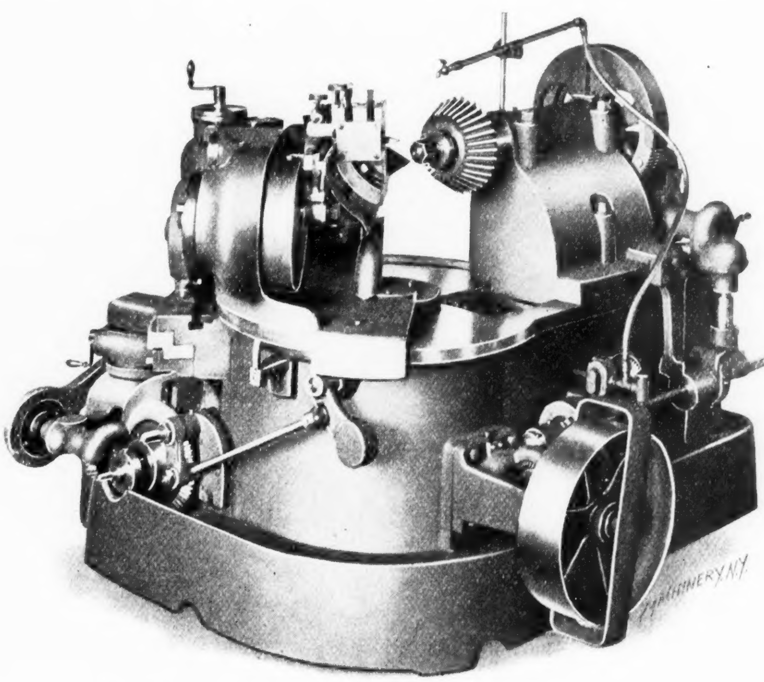


Fig. 151. Gleason Templet-controlled Bevel Gear Planing Machine.

The swinging movement for feeding the tool and the indexing of the work are taken care of by the mechanism of the machine without attention on the part of the operator. The swinging feeding movement about the vertical axis is effected by a cam and slotted link motion which may be adjusted to any degree of angular movement required. The head may be angularly adjusted with respect to its feed to agree with the pitch angle of the gear being cut. This is a more recent design than the last machine of this kind that was illustrated in MACHINERY,* differing from it particularly in the feeding arrangement. That previously shown was fed in to depth by a segment of a worm-wheel operated by a feed motion which could be given a forward movement for any required depth of cut, and a quick return, which was again reversed as soon as the indexing took place.

A French machine, built by Usines Bouhey, 43 Avenue Daumesnil, Paris, is shown in Fig. 152. While it operates on the templet principle, the movement for producing the desired outline is somewhat different from that employed in the Gleason machine, previously described. Instead of applying the movement derived from the templet to the tool, it is applied to the work, in a manner which will be evident from the illustration and the following description:

The cutting tool is carried by an overhanging arm, at the top of the frame, operated by the slotted crank shown. The work spindle carrying the wheel to be cut, the indexing worm-wheel, automatic dividing apparatus, etc., are carried on brackets attached to a swinging sector. The work spindle is so arranged that it may be adjusted longitudinally, to bring it into coincidence with the axis about which the sector is adjusted. The indexing mechanism is attached to a frame which is free to swing under the influence of the templet, which is attached to the upper end of an adjustable arm carried by this frame, and is located in a position to bear on a fixed guiding plate supported by the bed of the machine. It is held in contact with it by a weight and cord.

The action is as follows: The wheel, properly mounted on its arbor, is swung upward toward the reciprocating tool by a worm feed movement, applied to worm-wheel teeth cut in the periphery of the sector. While this angular feeding movement is in progress, a variable rocking is imparted to the entire indexing mechanism, work spindle and work, through the action of the templet on the stationary guide plate. It is this variable motion, controlled by the templet, which produces the desired outline on the tooth. When the correct depth of tooth has been reached, the feed is automatically tripped and the sector returned to its original position. The work is then indexed, the forward feed automatically re-engaged, and the cycle of operations continued until all the teeth are finished on that side, and the machine is stopped by the operator, and reversed for completing the teeth.

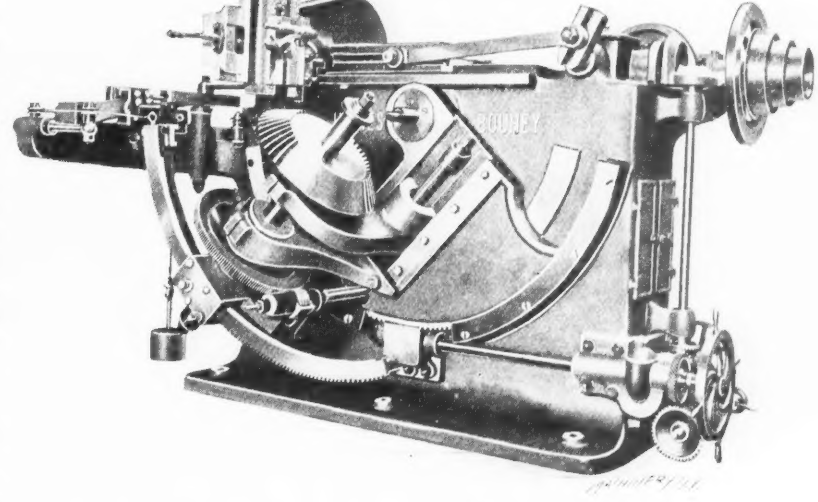


Fig. 152. The Bouhey Templet Planing Machine, in which Provision is made for the Cutting of Twisted Teeth.

A unique provision of this machine is that made for cutting bevel gears with twisted teeth, as shown in Fig. 152. It consists simply in providing for a positive connection between the indexing mechanism and the crank-shaft driving the tool slide, through the medium of change gears, so that the work and crank rotate in unison at the proper ratio to give the

* See article "Cutting Bevel Gears with Correct Teeth" in the June, 1898, issue of MACHINERY.

number of teeth desired in the work. Since the stroke then takes place while the work is rotating, a twisted form of tooth is produced. This tooth has the same shape (when seen at the ends) as when a straight tooth is being cut by the usual method. For cutting another gear of any angle to mesh with a gear cut this way—such, for instance, as the one shown in the engraving—it is only necessary to reverse the connection between the crank and the work so that rotation takes places in the opposite direction, and to set the slide and the templet for the new angle and the new tooth. This being done and the length of the stroke being the same, the teeth cut will exactly correspond in curvature with those previously cut in the mating gear.

Twisted tooth bevel gears are almost unknown in America, but have found considerable favor in Europe, where twisted tooth gearing of various kinds is in much greater favor than here. The teeth of gears thus made are not made to a true conical helix, since the motion is modified by the crank movement. All that is required, however, is that the curves of the gear and pinion should be such that the teeth of each will bear evenly on the other. This requirement is met in this machine.

An English machine, built by Greenwood & Batley, Ltd., Albion Works, Leeds, is shown in Fig. 153. The action and general arrangement of the machine are almost identical with that of the previous machine, excepting that no provision is here made for cutting twisted teeth. A comparison of the two tools serves well to show the wide variation in details resulting when two designers, independently work out the same idea. Aside from the difference in details, there are two salient changes in the mechanism. One of these relates to the feed, which is of the ratchet type, driven from a slotted disk. The other change relates to the mounting of the head, which is carried on two superimposed swiveling sectors, which pivot on a common center whose axis meets the line of travel

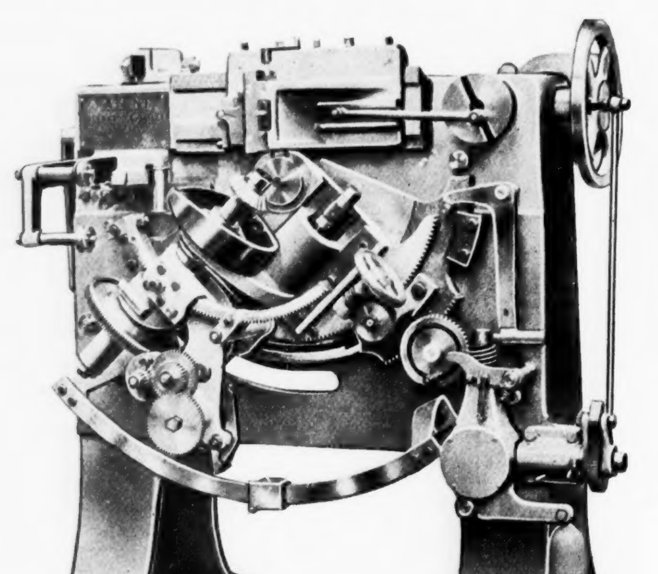


Fig. 153. The Greenwood & Batley Templet Bevel Gear Shaping Machine.

of the cutting tool. The outer sector is adjustable on the face of the inner one to suit the angle of the wheel being cut, while the feed movement is applied to the latter. Except for the particulars enumerated, the action is identical with that of the Bouhey machine.

In Fig. 154 is shown still another machine with the same relations between the tool, the work and the templet. As may be seen, however, the design is so different that there is no resemblance between it and those shown in Figs. 152 and 153. The tool is carried by a ram reciprocated by a mechanism similar to that used in a crank-driven shaper; the whole arrangement of the machine, in fact, resembles that of a shaper and is structurally derived from it. The work is carried on a spindle mounted in a frame hung about a horizontal axis from pivots seated in the arms shown projecting from either side of the head of the machine. The work is adjusted on the arbor to bring the apex of the pitch cone into the horizontal axis through the trunnions. A rigid outboard support for the work arbor is furnished, as shown.

The frame carrying the work is swung upward for feeding about the horizontal trunnions by a feed movement operated by the tooth sectors shown on each side, which are engaged by pinions on a horizontal shaft, connected, in turn, by gearing with a ratchet disk seen at the side of the head. From this

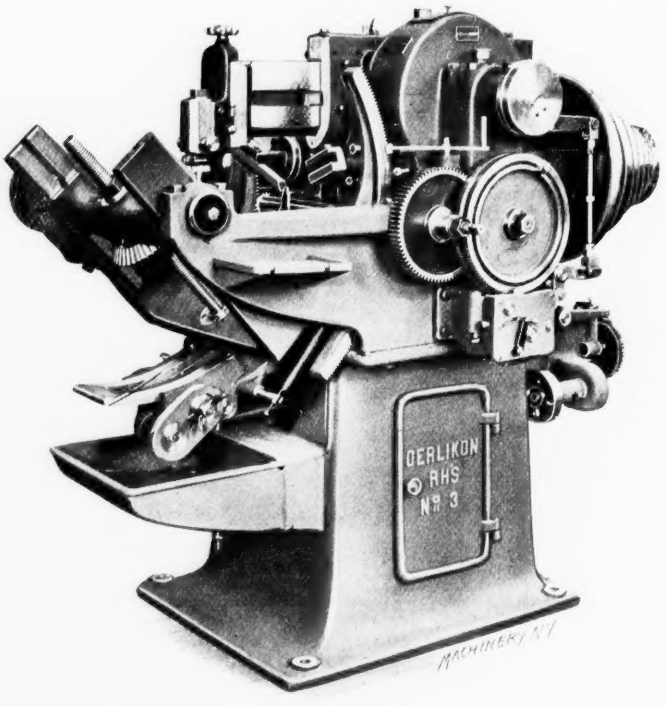


Fig. 154. The Oerlikon Single-tool Templet Bevel Gear Shaper.

the feed movement is obtained. Stops are provided on the face of the disk which limit the swinging feed movement, and actuate mechanism for returning the work rapidly when the cut has been completed, so that the tool is clear for indexing the blank. When the indexing has taken place, the upward feed is again automatically thrown in. As in the Greenwood & Batley machine, the entire dividing mechanism is attached to a bracket carrying an adjustable arm to the upper end of which the templet is attached. By means of springs this templet may be caused to bear on adjustable contact surfaces at either side, depending on which side of the tooth is being cut. The templet, bearing on the guide attached to the head of the machine on the side farthest from the observer, is somewhat imperfectly shown in the engraving.

We think it will be agreed that this tool gives evidences of careful design and construction. It has a decidedly rugged and business-like look. It is built by the Societe Suisse pour la Construction de Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland.

* * *

The United States Navy Department has decided to install oil-burning apparatus on two of the five torpedo-boat destroyers which are now being constructed by Cramp & Sons, the Bath Iron Works, and the New York Ship Building Company. Some weeks ago, Secretary Metcalf decided that it would be advantageous to have these boats equipped for burning oil instead of coal. The practicability of extending this system to torpedo-boat destroyers already in service has been talked of, and such a change carefully considered by experts, who have come to the conclusion that it would be impracticable to convert into oil-burning craft torpedo-boat destroyers already completed. Aside from the expense which such a change would entail, it was found that the installation of such apparatus would involve much work in the way of alterations, and this could only be done under great difficulty.

SPECIAL MACHINES AND TOOLS USED IN UPRIGHT DRILL MANUFACTURE.

One of the thriving cities of the Middle West—Rockford, Ill.—has acquired considerable distinction within the past few years as a machine tool manufacturing town. Six concerns building lathes, planers, drilling machines, milling machines and shapers are now located there; but machine tool building is by no means a new development in Rockford. One of the oldest concerns in the United States is the W. F. & John Barnes Co., builder of foot-power lathes, foot-power woodworking machinery and upright drilling machines. From this concern three other machine tool companies in Rockford have developed, these being the Rockford Drilling Machine Co. (formerly B. F. Barnes Co.), the Barnes Drill Co, and the Mechanics Machine Co.

The lively competition existing in the manufacture of upright drilling machines has led to the development of many interesting time- and labor-saving devices in the Rockford shops, which are largely used on drill presses. The following article relates to the shop practice of the Rockford Drilling Machine Co., and the special tools illustrated and described are to a large extent the result of the ingenuity and resourcefulness of Mr. R. Milne, the superintendent. The devices which are adapted to the drill press make good object lessons to the intending purchasers, showing them to what extent this humble machine can be used for manufacturing parts that are commonly done on much more costly tools.

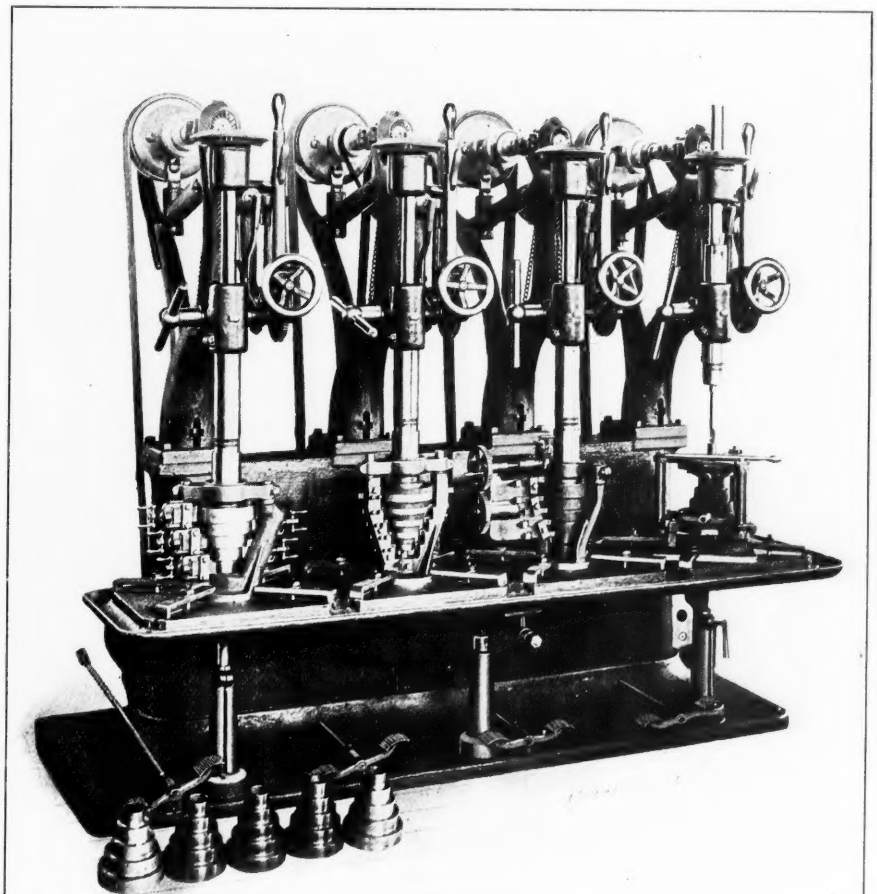


Fig. 1. Set of Tools used on Gang Drill for Boring and Turning Cone Pulleys.

Figs. 1, 2, 3, 4, and 5 are examples in point. Fig. 2 illustrates a cam-cutting attachment for cutting a special cam used in a certain style of drill press. This cam operates the feed motion of the drill spindle through ratchets. The construction of the rig for cutting the cam *A* is quite plainly shown in the engraving. A small gear is mounted on the lower part of the drill spindle, which drives a train of gears and worm-wheels. The first worm *B* and worm-wheel gives the rotary motion to the mandrel on which the cam is mounted, and the second worm-wheel driven by gear *C* operates the crank-shaft *D*, to which the slide mounted on the base *E* is attached by the connecting-rod shown in front. This slide reciprocates the cam underneath the end mill mounted in the drill spindle, and thus generates the required curve. The machine operates automatically, the regular feed of the drill press moving the end mill downward until the required depth is reached, when an automatic throw-out stops the feed.

Fig. 1 is another illustration of unusual drilling machine work, a set of special tools being provided for finishing small cone pulleys. The rough casting is mounted in a jig, as shown at the right, and the spindle hole is bored out, the boring tool being supported by a bushing in the top of the jig. The casting is then reversed and placed in the next jig at the left, on which is mounted a set of turning tools. As the casting is revolved, these tools face the edges of the cone steps, the feed being automatically effected by the mechanism. The next step is turning the faces of the pulleys. This jig is simpler in construction. The casting is fed downward past the turning tools held in the sides of the yoke. When this operation is finished, the steps have been turned straight. The jig at the extreme left is for coning the steps, the tools being forming tools, which are fed by hand.

Fig. 3 illustrates a drill press jig for boring pulleys. It consists of a base in which are vertically mounted three square-thread screws which act as the supports for the top plate carrying the guide bushing. The movable part of the jig is operated by three hand-wheels connected by a bicycle chain running on sprockets and held closely in contact with the sprocket by adjustable idlers. A novel feature of the jig is the jaws clamping the edges of the pulley rim. These jaws are notched in vee shape, and grasp the pulley rim internally at the top and externally at the bottom in the example shown, but a larger or smaller size would be grasped in reverse manner by the upper and lower jaws. The jig is adapted to pulleys of all sizes within its capacity, the notched jaws holding any size pulley within these limits concentric with the central hole.

Fig. 5 is a simple rig applied to a 26-inch drill for boring drill spindles. The drill is held stationary, being mounted on the table, and is of the oil tube variety. The lips are ground to cut left-handed in order to accommodate the drill to the left-hand rotation of the work. A gear is mounted on the lower end of the drill spindle, which drives a gear mounted on a sleeve in which the spindle to be bored is chucked. Lubricant is forced to the point of the drill and chips and oil are forced downward onto the table. The rig is very cheap and effective in operation. It consists essentially of only two castings, and the rotary sleeve, together with the chuck, clamping screws and driving gears.

Fig. 4 shows a set of tools used on a gang drill for boring and finishing collars. The rough casting is first caught in the three-jawed chuck at the right, and reamed and faced. It is then removed to the center fixture, which has an expanding arbor worked by the nut beneath. The arbor is expanded inside the bore and holds the casting firmly for the rough turning operation performed by the tool shown above it. The finishing operation is conducted in the same way, the bushing being held in the same manner and turned by a finishing tool of the same style as the roughing tool.

Figs. 7 and 8 show two views of a novel machine for cutting oil grooves in loose pulleys and cone pulleys. A loose pulley *A* is shown in place in the chuck *B* in Fig. 7, and the end of the cutting bar is shown projecting through the bore in the hub. The chuck used for holding loose pulleys consists of two sectors *B B* turned with concentric grooves to suit the various diameters of pulley rims. The handle *H*, shown in front in Fig. 8, loosens and tightens the frame holding these sectors.

The pulley is placed in position in the sectors, and by tightening the handle they are made to grip the pulley rim firmly. For small work, a three-jawed chuck *G* mounted on a plate, shown leaning against the base in Fig. 7, is employed. For cone pulleys the rig used for cutting loose pulleys is employed, and the adjustable support *E*, shown underneath, is used to support the outer end of the cone. The action of the cutting tool is a combination of reciprocating and up-and-down movements, as is required for cutting a key-seat deepest in the center. The cutter bar *F* is mounted on trunnions on a slide, and the rear end *C* is pivoted to the end of a connecting-rod *D*, also mounted on trunnions in a second slide. This connecting-rod is driven by a slotted crank disk, the stroke thus being made adjustable. The point of connection of the cutter bar to the end of the connecting-rod may be varied by changing the position of the cutter-bar pivot in the connecting-rod

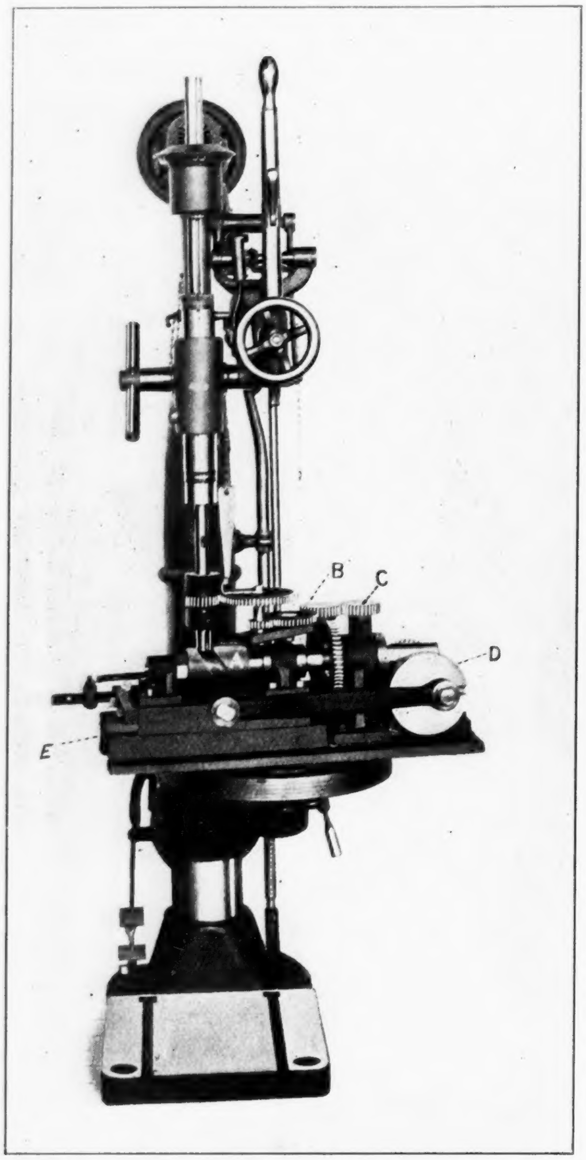


Fig. 2. Cam-cutting Machine used on Upright Drill.

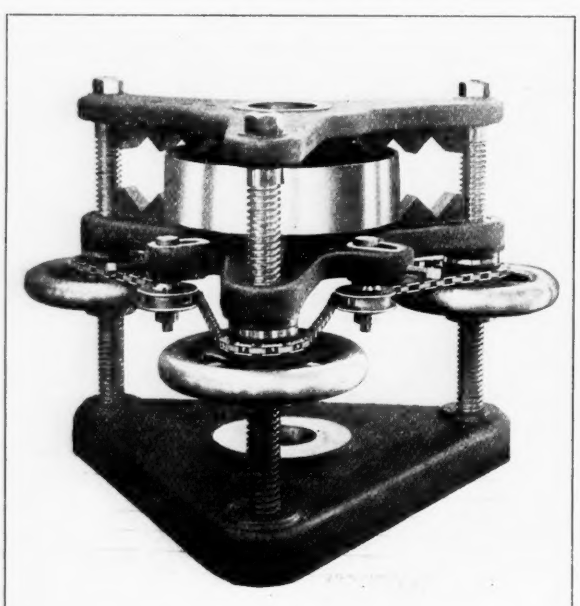


Fig. 3. Jig for Boring Pulleys.

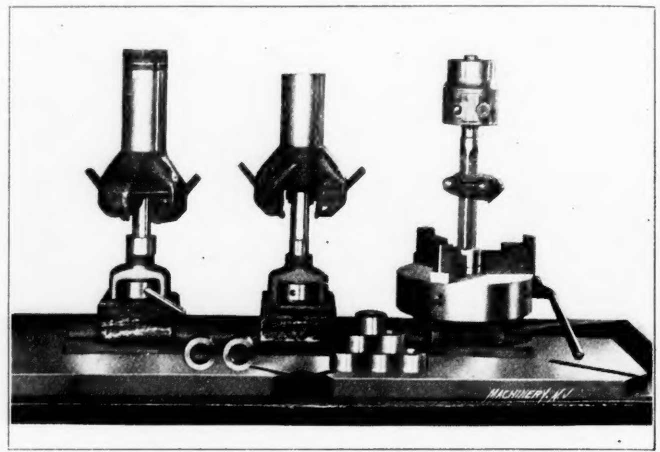


Fig. 4. Jigs for Boring and Turning Collars.

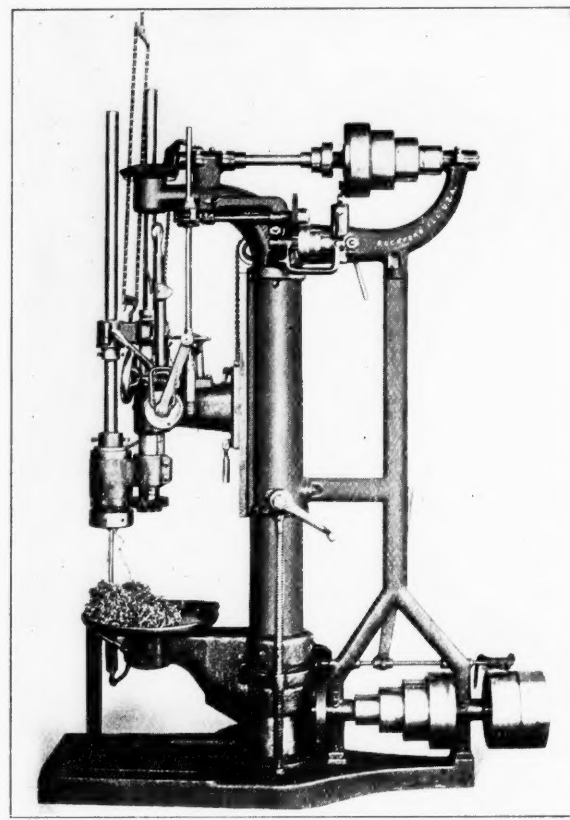


Fig. 5. Attachment for Boring Drill Spindles.

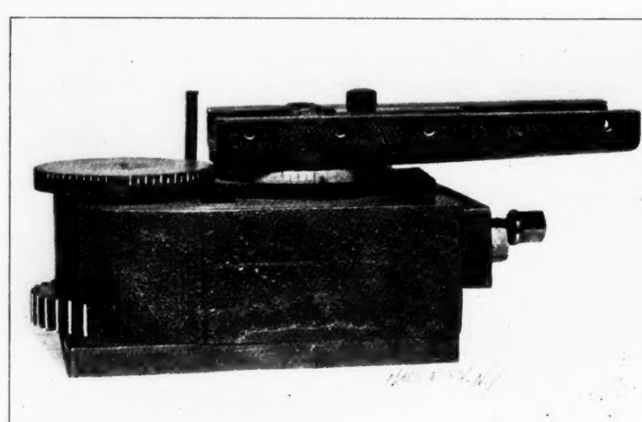


Fig. 6. Jig for Graduating Compound Rests, with Hob.

T-slot. Thus the length of the stroke may be adjusted by changing the position of the crank-pin in the slotted crank disk, and the up-and-down movement of the cutter bar is adjusted by changing the location of the pin connecting it to the end of the connecting-rod. The depth of an oil groove is not necessarily a widely varying dimension, but the fact that the depth produced by the mechanism depends on the length of stroke, makes it necessary to change the up-and-down motion whenever the position of the crank-pin is changed on the crank disk. This machine is rapid in operation.

The graduations on the drill sleeves or quills are rolled in by a special device. The lines are raised on the barrel of a hardened rotary die, and this die is geared to a reciprocating table in which the quill is firmly fixed. One pass of the quill underneath the die imprints the graduations. The quill is then transferred to a simple hand jig, and located therein so that ordinary figure dies mounted in square slots will be in position corresponding to the inch graduations. These numbers are successively struck with a hammer, thus sinking the numbers into the quill. A hardened die or hob is also employed for rolling the graduations into the edge of lathe compound rests. One rotation does the work. The hob or die is mounted on a spindle which is geared to the face-plate on which the compound rest is mounted, the two thus being made to rotate together positively. See Fig. 6. A variation in diameter of 1/32 inch does not affect the accuracy of the graduations produced, as the gears force the compound rest and the hob to rotate in unison with the rotation of the gears driving them. In other words, the turning of the compound rest is not effected by the hob, but by the gear mounted on the face-plate spindle.

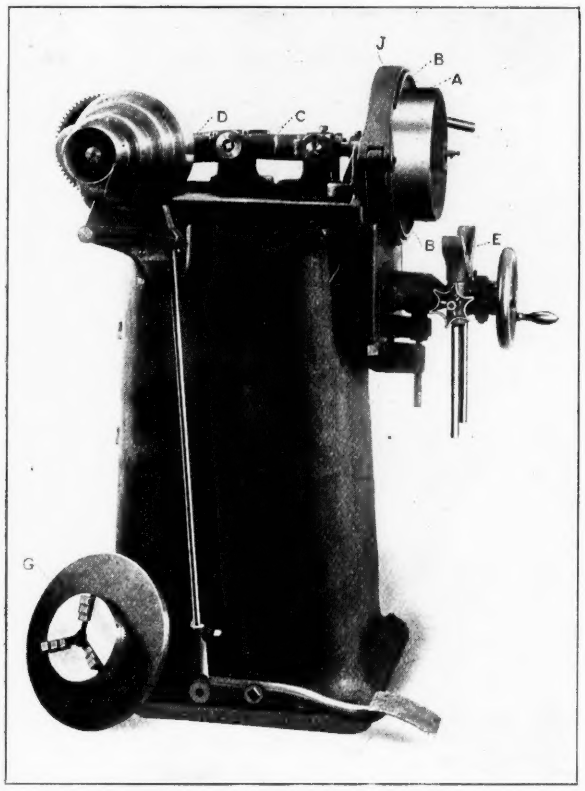


Fig. 7. Keyway-cutting Machine.

Fig. 9 shows a keyseater which was made from a drilling machine frame, with a few changes in the pattern. The vertical ram which takes the place of the drill spindle in a drilling machine, is operated by a walking-beam having slotted joint connections for the ram and the connecting-rod slide. The crank-shaft is driven by a pinion belted to the cone pulley at the top of the machine. It will be observed that the changes required to convert a drilling machine into a vertical slotter were comparatively small. The machine works very effectively and rapidly. It is employed for keyseating the gears and pulleys, the work being mounted on a table having hand-fed adjustment. The machine works so rapidly that the greater part of the operator's time is taken up in clamping the work in place and removing it from the machine.

The machine shop and foundry buildings are built parallel, along the side of a low bank, the foundry being placed next to the bank and a railroad switch on the bank enables pig iron, sand, coal, coke, etc., to be delivered to the foundry by gravity. The space between the foundry building and the machine shop building was lately covered over, converting the space into an ideal castings court. This is illustrated in Fig. 10. A feature of interest is the crane provision made for transferring the castings from the foundry to the castings court. The foundry is provided with a hand traveling crane of the same type as that indicated in Fig. 10, having an I-beam girder for supporting the trolley. At various points in the foundry the I-beam girders are erected at right angles to the crane runway so as to be directly in line with the crane girder. With this arrangement the crane trolley can be run from the traveling crane to the stationary girder tracks and the load deposited or picked up at almost all points in the

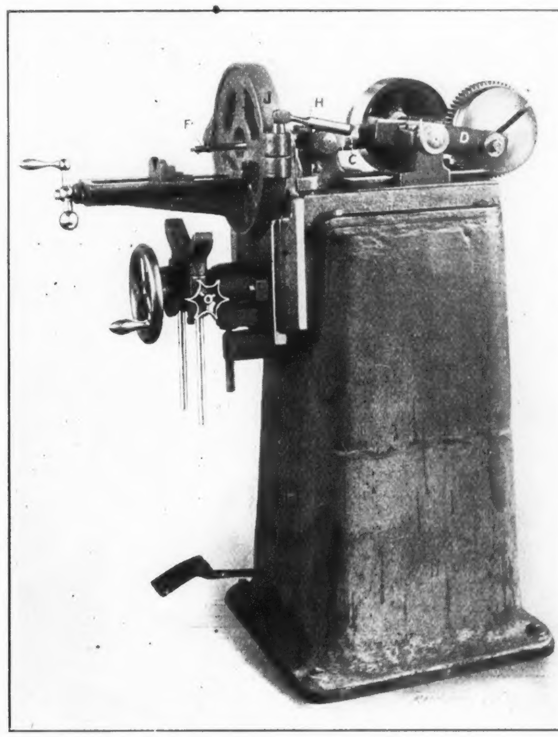


Fig. 8. Keyway-cutting Machine.

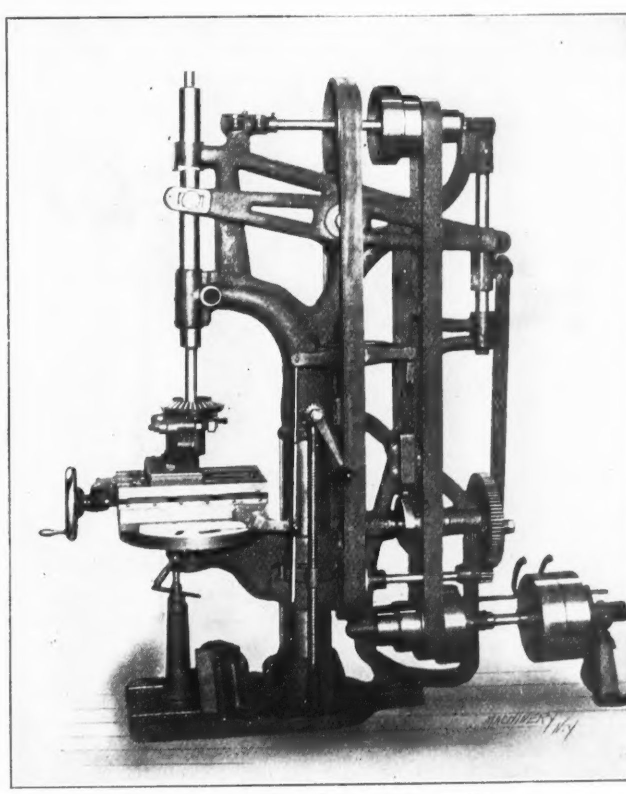


Fig. 9. Keyseater built on Drill Press Frame.

foundry. The same arrangement provides connection with the castings court. A casting can be picked up in a far corner of the foundry, transferred to the foundry crane and carried along until opposite the opening leading to the castings court, where it is transferred to the castings court crane and then deposited in the castings court. Automatic safety devices are provided which prevent the trolley running off the end of the crane girder, except when opposite the girder runways, and when the transfer is taking place the crane is locked in position.

The system of keeping stock parts in the erecting shop is a radical departure from the systems in common use in most manufacturing plants. Instead of keeping machine parts in

Fig. 10. Castings Court between Machine Shop and Foundry.

a storeroom under the charge of a storekeeper, they are stored in metallic bins made by the Lyon Metallic Mfg. Co., located under the work benches. These bins extend nearly the whole length of the shop, and are about 1,100 in number. The stock is freely accessible to the men, no requisitions being necessary. The storekeeper takes an inventory of a certain number every day, and in six months has inventoried the whole stock. The loss of parts that cannot be accounted for is stated to be so small as to be practically negligible. Jigs and fixtures are also stored in the machine shop bay, where they are in charge of the sub-foremen. The jigs are kept in metallic lockers having wire screen doors of large mesh. The contents of each locker are plainly visible, and ordinarily the machine men are free to get any jigs that they require. The system of manufacture is such that the men act as their own inspectors of jigs and fixtures, and defects are promptly reported to the toolmaking department for correction.

* * *

The following statements by Mr. Marconi, made at the general meeting of the Marconi Wireless Telegraph Co., in London, this spring, are of interest as indicating the progress of wireless transatlantic telegraphy. The seven and one-half months' experience since the transatlantic service was inaugurated, has shown that obstacles which many regarded as insurmountable, such as the interference with other stations, and the difficulty of transmitting messages for long distances during the day-time, have been overcome. For some months past the majority of the messages have been carried across the ocean during the day-time, and no interference whatever has been caused by the operation of the powerful long distance transatlantic stations with the working of the ship-to-shore communications. A speed of as high as 24 words per minute has been achieved. Mr. Marconi also states that with slight modifications of the details of the apparatus, at a very small cost, a speed of at least 30 words per minute can be obtained. Recent developments also make it possible to effect duplex working between wireless stations; that is, each station will be able to send and receive messages simultaneously.

SPECIAL TOOLS IN THE ROCKFORD MACHINE TOOL CO.'S SHOP.

The following illustrations show some special machines designed and built by the Rockford Machine Tool Co., Rockford, Ill., to facilitate the manufacture of shapers and planers, which are its product.

Feeling the need for an efficient and low-priced vertical milling machine, two were improvised from the regular shaping machines built by the company, by making the changes partially shown in Fig. 1. The tool slide on the end of the ram is replaced by the cutter spindle and its driving gear. The ram is adjusted in and out by the crank on the ram stud. This, it will be noted, is the regular arrangement for changing the relative position of the ram in its stroke when used as a shaper. The feed mechanism is belted to the counter-shaft by a separate belt, and thus works independently of the drive. Four changes of feed are provided, with reverse. The sliding pinion on the cross feed screw can be slipped onto the elevating shaft and the table fed up or down, if desired. The machine is driven by two counter-shafts and cone pulleys, giving five spindle speeds. As stated at the beginning, two of these machines are in use, and they have proved to be very satisfactory. They are used for milling T-slots and doing much other milling required in the manufacture of shaper parts. One of the uses that has been profitable is milling dovetail slides, suitable fixtures being provided for chucking the work quickly and accurately so as to preserve the standard angle. The machine will carry a 5-inch face mill and drive it efficiently.

Figs. 2, 3 and 4 show a home-made graduating machine that does good work at a high rate of speed. Fig. 2 shows the

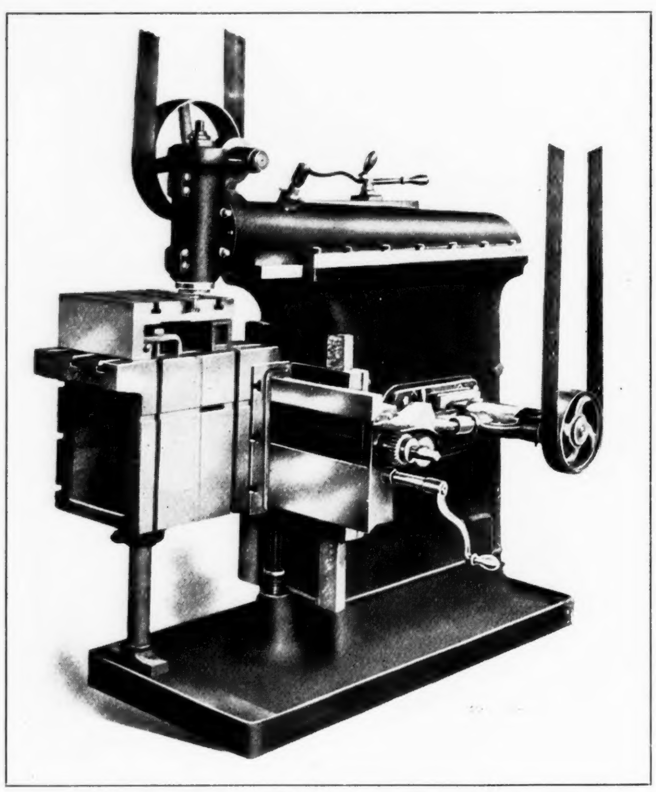


Fig. 1. Shaper converted into a Vertical Milling Machine.

machine set up for graduating the bases of the company's regular swivel base shaper vise, while Fig. 3 shows it in use graduating the saddle of a 28-inch Rockford planer. Figs. 5 and 6 indicate the character of the work done on vise base and planer saddle. It will be understood, of course, that in one case the graduations are made on the cylindrical surface of the swivel base, and in the other case the graduations are radial, being made on the face of the saddle. The machine will graduate along the edge of work ranging from ¾ to 36 inches diameter. The planer saddle shown on the machine in Fig. 4, is graduated all around the circle, and it requires only about 1½ minute's time to complete the work. An automatic trip is provided which stops the work from turning further when the exact number of graduations have been

made for which the machine is set. This feature takes care of such work as shaper vise bases and swivel plates for the head which are graduated from 90 to 180 degrees. The construction of the machine is simple, and as plainly shown, it is operated by hand. The hand-wheel shaft carries a bevel gear driving a bevel pinion operating the ratchet feed. On the end of the hand-wheel shaft is a cam having five projections. This cam operates a plunger, retracted by a coil spring. One of the cam projections is longer than the others,

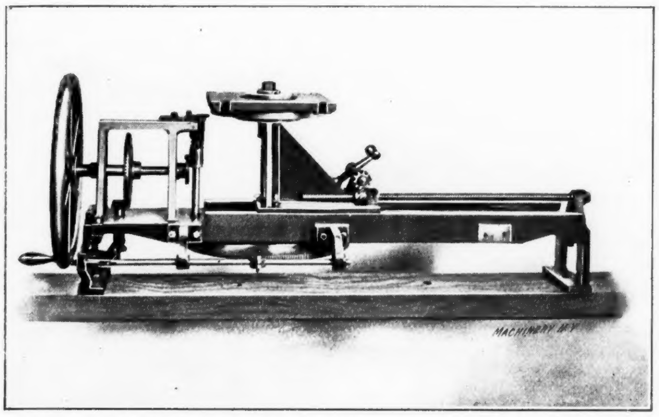


Fig. 2. Home-made Graduating Machine graduating Base of Swivel Vise.

thus making the long graduation mark required to distinguish every fifth degree position. The graduating tool is a sharp pointed piece of steel mounted on top of the plunger, as indicated in Fig. 2, for graduating along the edge of work. The bevel gears operating the indexing mechanism are in the ratio of 5 to 1, and the crank working the indexing lever is adjustable, thus permitting one or more notches to be engaged by the ratchet. This makes it possible to cut graduated collars to suit various pitches of screws, with the same index plate.

When cutting graduations on a flat surface, as indicated in Fig. 3, a different arrangement of the cutting tools is obviously required. In this case it is necessary to provide release for the tool in order to clear the work as it indexes. In the illustration the cutting tool is shown clear of the work,

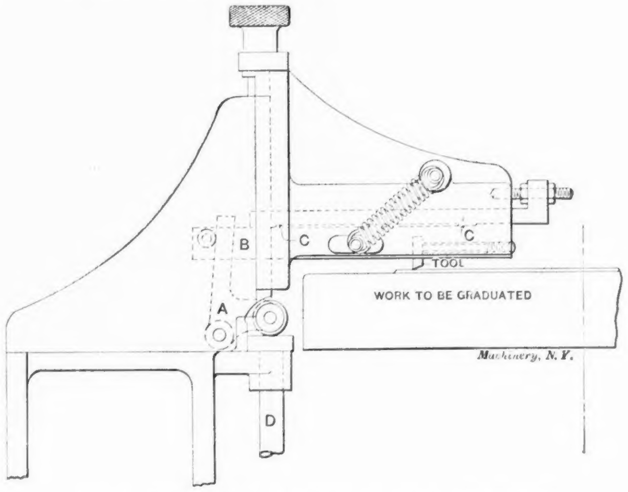


Fig. 4. Construction of Fixture for Radial Graduating.

but it lowers to the depth of the cut in the first 1/16 inch of the movement, and then moves in a parallel line to the end of the cut, when it automatically raises clear of the work and is brought back to the starting point by two springs, one of which is shown in an inclined position on the horizontal part. This release motion is effected by a simple mechanism under the slide.

The construction of the release motion is shown in the line illustration, Fig. 4. The vertical plunger *D* operates a bell-crank lever *A*, and this in turn operates a cutter slide *B* by working against a small roller mounted in the slide. This construction permits the tool to be adjusted vertically to the work by a screw and knurled knob on top of the fixture, and vertical adjustment of about 1 inch is thus provided. The engraving also shows the relief motion for the cutter slide, this being effected by a raised portion *C* about 1/32 inch high at each end of the slide. The illustration shows the cutter slide at the end of the stroke, with the tool clearing the work. On the first 1/16 inch movement of the cutter slide it moves up onto the incline, forcing the tool into the cut, then travels along to the end of the cut, and then is carried back to its starting point by the springs. The springs thus serve to hold the cutter slide up as well as to bring it back to the starting position.

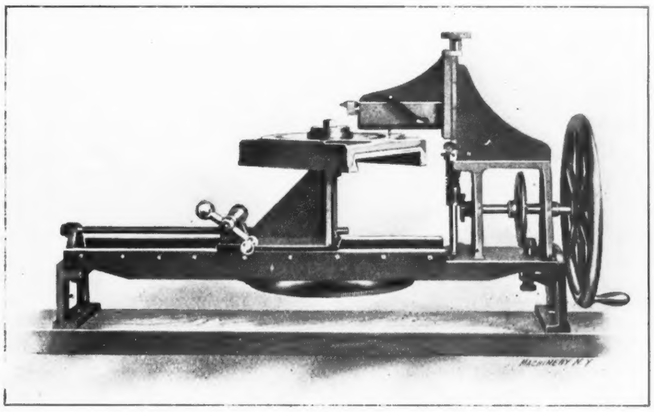


Fig. 3. Machine graduating Planer Saddle.

The index plates have been made accurate, and are 20 inches in diameter. A number have been provided to suit the various divisions required. The adjustment of the machine for circles of varying diameters is simply effected by means of the horizontal slide and screw which is worked by a revolving nut operated by a handle, through spiral gears. The machine, of course, could be arranged to be power driven, but the short time required for graduating a full circle and the small amount of power required to operate it make power unnecessary.

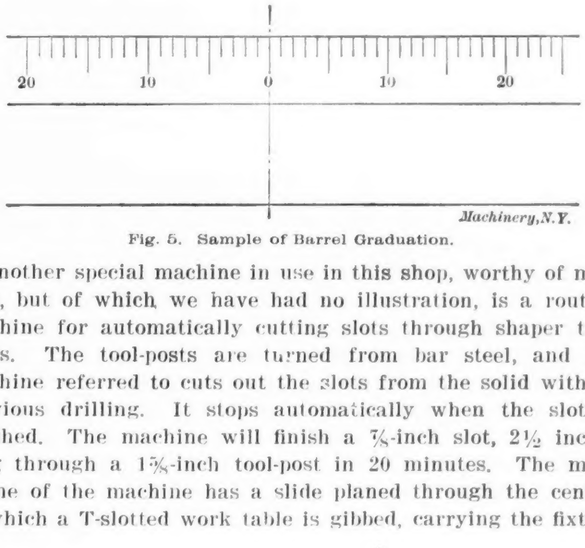


Fig. 5. Sample of Barrel Graduation.

Another special machine in use in this shop, worthy of mention, but of which we have had no illustration, is a routing machine for automatically cutting slots through shaper toolposts. The tool-posts are turned from bar steel, and the machine referred to cuts out the slots from the solid without previous drilling. It stops automatically when the slot is finished. The machine will finish a 7/8-inch slot, 2½ inches long through a 1⅝-inch tool-post in 20 minutes. The main frame of the machine has a slide planed through the center, to which a T-slotted work table is gibbed, carrying the fixture

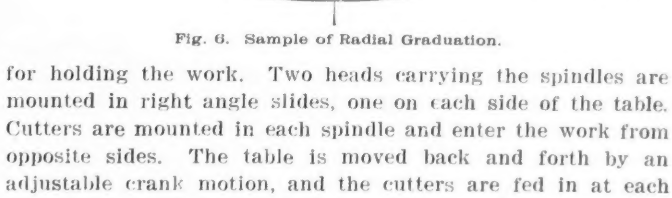


Fig. 6. Sample of Radial Graduation.

for holding the work. Two heads carrying the spindles are mounted in right angle slides, one on each side of the table. Cutters are mounted in each spindle and enter the work from opposite sides. The table is moved back and forth by an adjustable crank motion, and the cutters are fed in at each end of the stroke. It stops automatically when the cutters are within 1/32 inch of the center. At this point one cutter is withdrawn and the other cutter is fed through to remove the remaining stock.

The simple boring jigs used for boring the shaft holes in planer beds and shaper frames are worthy of mention because of their simplicity and effectiveness. A jig consists of two cast iron plates, planed on both sides and held together by bolts and distance pieces. It is used on a Detrick & Harvey horizontal boring machine and supports the boring-bars, which are held in bushings in the side plates. The bars are driven by universal joints so that the jig supports the bar entirely independently of the work spindle. The planer casting is mounted on the table between the jig plates, the jig and the casting being located by certain gage points and clamped in position. When the various sizes of jigs were bored, an extra plate was bored simultaneously for each jig, and this is employed as a testing jig for the driving gears, studs being mounted in the holes on which the spur gears are set for testing. Obviously, these studs must have the same center distance for each size machine as the holes bored in the beds.

All these machines and special appliances were designed by Mr. E. D. Westrip, the general manager.

* * *

Some figures which are interesting in view of the present agitation for laws relating to employers' liability for accidents, are quoted by the *Mechanical Engineer*. It is usually considered that with advancing age the liability to accident increases. The figures quoted, which have been compiled by Sir John Brunner, and were first published in the *Times*, London, cover an investigation extending over fifteen years, and tend to disprove the previously mentioned assumption. In fact, these figures indicate that young men, under thirty years of age, are most liable to accidents, as will be seen from the table below.

Age.	Number Employed.	Percentage of Accidents Per Year.
18 to 25	633	8.5
26 to 30	533	6.8
31 to 35	616	4.2
36 to 40	656	3.6
41 to 45	531	2.8
46 to 50	382	3.7
51 to 55	251	2.4
56 and over	246	2.4

It may, of course, be assumed that the marked reduction in the percentage of accidents after the age of fifty is, to a slight extent, due to the fact of putting elderly men on less dangerous work, but it is also indicative of the fact that experience and care will increase with advancing years, and Sir John Brunner draws the conclusion that no employer is justified, not even in his own interest, in refusing to take elderly men in his service, or in dismissing them for the reason that they are more liable to accidents than younger men.

If a man is careful to avoid accidents happening to himself, he is, as a rule, also careful in preventing accidents happening to the machinery on which he is employed, and the figures quoted may therefore be considered as an indication that young men are not necessarily the best investment in a shop, but that men of more advanced years are likely to fill their places equally well, when all factors are considered.

* * *

A maddening and humiliating experience for a manufacturer to undergo is to develop a mechanical feature in an unobtrusive way and wake up some fine morning to find that another fellow had received the credit. It is not an unknown happening for a machine tool builder to work out some little kink or attachment which is good in its place but is of scarcely sufficient importance to pay the cost of taking out a patent to protect his rights. Another concern may adopt the same idea, and it is not an unknown occurrence for the copyist to be awarded credit for its origin. Still worse cases have happened, the copyist having the hardihood to actually patent an idea worked out by another. Of course, it is more charitable to believe that such cases are the result of an independent development, but whether so or not, it does not much help the feelings of the originator. What is his remedy? Show these minor developments in MACHINERY and get the credit that is your due. It helps the trade and it will help you.

MILLING SQUARE THREADS AND TURNING PULLEYS ON A DRILL PRESS.

To cut nicely finished square-thread screws on an ordinary drilling machine seems a most extraordinary operation, quite out of the range of practicability, but a simple attachment designed and used by the Mechanics Machine Co. of Rockford, Ill., does the work satisfactorily, and with a minimum of attention. The attachment, shown in Fig. 1, consists of a plate on which is mounted a master screw (shown in front) and the blank to be threaded. The master screw is splined and is driven with a worm and worm-wheel by a round belt leading to a grooved belt mounted on the regular vertical feed shaft. The master screw is directly connected with the blank shaft work spindle by spur gears without an intermediate gear; consequently the master screw is of opposite lead to the screw produced. In the illustration, a right-hand square-thread screw is being cut, the master screw being a left-hand square-thread screw. In operation, the master screw and the blank travel together to the right, the master screw reacting against a simple nut engagement shown in the front. The threading is a milling operation, as is plainly evident, the cutter being a plain, flat

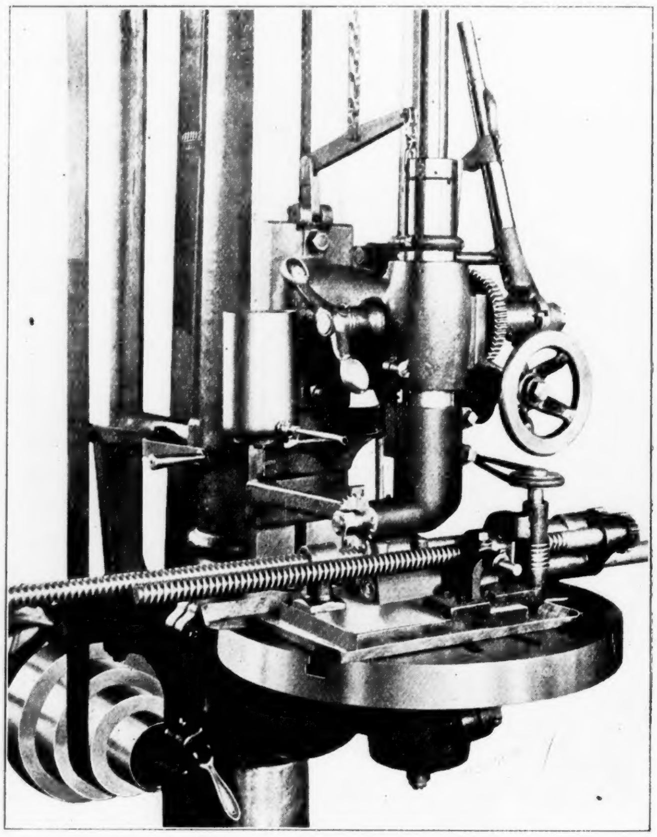


Fig. 1. Milling Square Threads on a Drill Press.

milling cutter on a horizontal shaft mounted in a casting attached to the lower end of the quill. It is driven by the drill spindle through bevel gears.

The screw milling attachment was designed on account of scarcity of help and machinery in the rush of business last year, and it has proved to be a wonderful time and labor saver. It is used for milling the table elevating screws used on upright drill presses manufactured by the company. A screw 27 inches long, 1 inch diameter, can be cut in 1½ hour, the screws produced being smooth and perfect copies of the master screw except in the change of hand or direction of spiral. An intermediate gear would correct this, but for the sake of simplicity it is omitted. The attachment works automatically, the principal attendance required being to put in a new shaft when the previous one is completed. The screw being cut is held by an ordinary spring collet on the work spindle. The attachment is extremely simple in construction, and being capable of producing threaded work of high accuracy because of directly reproducing the master screw, it would seem to have many possible uses.

Another drill press attachment used in the same shop, of almost equally surprising use, is that shown in Fig. 2 for

turning crowned pulleys. The principle of this attachment is not new, pulley milling machines having been used by other machine tool builders for several years, but the development of a drill press attachment for such work, we believe, is new. The attachment is simple, consisting of a base carrying a horizontal spindle, on one end of which the pulley is mounted and on the other end a worm-wheel, engaging a worm. This combination is driven by a second worm and worm-wheel in order to get the required reduction of motion. On the upper end of the second worm shaft is a pulley belted to another pulley mounted on the cutter-head. This cutter-head is fixed in the spindle with a Morse taper shank, fitting the drill socket. Of course the pulleys are bored and keyseated previous to the milling operation.

The milling attachment is located on the drill press table, so that a vertical plane through the work or pulley shaft and coinciding with its axis, stands a short distance to one side of the spindle center line. In the other plane at right angles to the pulley shaft the center line of the spindle coincides with the center plane of the pulley being milled. This position of a milling cutter of sufficient diameter to sweep the entire

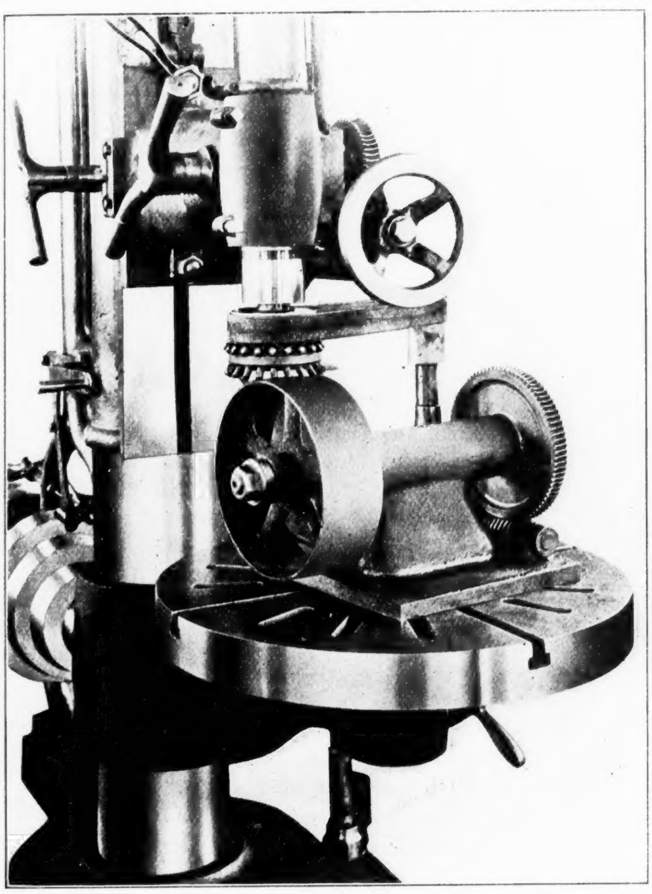


Fig. 2. Milling Crowned Pulley Faces on a Drill Press.

face of the pulley, generates a curved surface that answers the requirements of crowning. The attachment is automatic and requires but one hour to face and crown a 12 x 4-inch pulley. High-speed steel cutters are used, which require regrinding very seldom, so the labor cost of machining the faces of pulleys is reduced to but little more than that of putting the work on the attachment and removing it when finished.

* * *

The importance of well lubricated bearings, as well as the importance of an oil suitable for lubrication purposes, is given in a paper before an English society of engineers, by Mr. T. C. Thomson, some weeks ago. He stated that in a certain machine shop driven by an electric motor, the power needed to drive the shafting and the machine running idle amounted to 37 K. W. when one kind of oil was used, and 25 K. W. when a better quality of oil was substituted. The total rated capacity of the motor was only 65 K. W., so that even with the best oil, it is seen that the frictional losses remain a very substantial fraction of the total energy expended.

JIGS AND FIXTURES—4.

EINAR MORIN.*

CLAMPING DEVICES.

In order to hold the work rigidly in the jig, so that it may be held up against the locating points, while the cutting tools operate upon the work, jigs and fixtures are provided with clamping devices. Sometimes a clamping device serves the purpose of holding the jig to the work, in a case where the

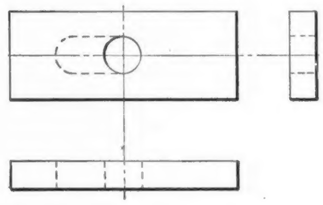


Fig. 37. Form of Clamps used in Jigs and Fixtures.

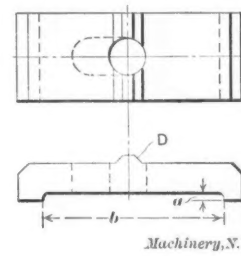


Fig. 38. Improved Form of Clamp.

work is a very large piece and the jig is attached to the work in some suitable way. The purpose of the clamping device, however, remains the same, namely, that of preventing any shifting of the guiding bushings while the operation on the work is being performed. As has been previously mentioned, at the time when the general principles of jig and fixture design were treated in the first installment of this series

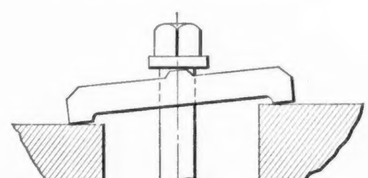


Fig. 39. Action of Clamp shown in Fig. 38 when used to clamp Work which is not Level with the Clamping Surface.

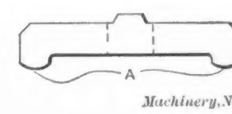
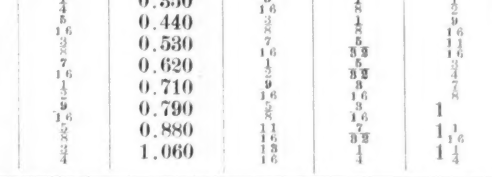


Fig. 40. Clamp shown in Fig. 38, Further Improved.

(April issue), the clamping device should always be an integral part of the jig body in order to prevent its getting lost.

The clamping device may either directly clamp the work to the jig or *vice versa*, but very frequently the clamps simply hold in place a loose or movable part in the jig, which can be swung out of the way to facilitate the removing and the inserting of the work in the jig. The work itself is in

TABLE V. DIMENSIONS OF COLLAR-HEAD SCREWS.



A	B	C	D	E	F	St'd No. of Threads per inch.
3/16	3/16	0.260	1/4	3/32	3/8	24
1/4	1/4	0.350	5/16	1/8	1/2	20
5/16	5/16	0.440	3/8	1/8	9/16	18
3/8	3/8	0.530	7/16	5/32	11/16	16
7/16	7/16	0.620	1/2	5/32	3/4	14
1/2	1/2	0.710	9/16	3/16	7/8	13
9/16	9/16	0.790	5/8	3/16	1	12
5/8	5/8	0.880	11/16	7/32	1 1/16	11
3/4	3/4	1.060	13/16	1/4	1 1/4	10

turn clamped by a set-screw or other means passing through the loose part, commonly called leaf. The simplest form of clamping device is the so-called clamp, of which a number of different forms are commonly used. Perhaps the most common and most reliable of all clamps is the one shown in Fig. 37. This kind of clamp is also commonly termed a strap. It is simple, cheap to make, and for most purposes it gives satisfactory service. The clamp shown in Fig. 38 is practically made on the same principle as the one shown in Fig. 37,

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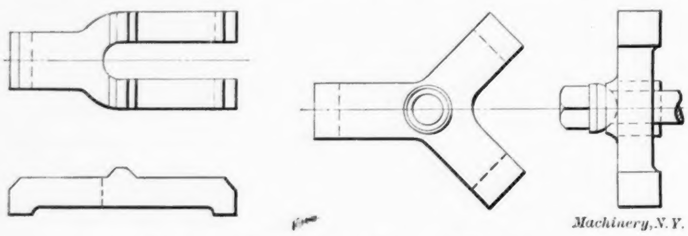
but several improvements have been introduced. The clamp is recessed at the bottom for a distance *b*, to a depth equal to *a*, so as to give a bearing only on the two extreme ends of the clamp. Even if the strap should bend somewhat, on account of the pressure of the screw, it will be certain to bear at the

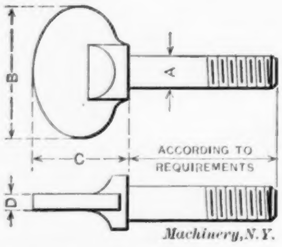


Figs. 41 and 42. Special Forms of Clamps.

ends, and exert the required pressure on the object being clamped. This strap is also provided with a ridge at *D*, located central with the hole for the screw, as shown in Fig. 38. This insures an even bearing of the screw head on the clamp, even if the two bearing points at each end of the clamp should vary in height, as illustrated in Fig. 39. The clamp in Fig. 37 would not bind very securely, under such circumstances, and the collar of the screw would be liable to break off, as the whole strain, when tightening the screw, would be put on one side.

A still further improvement in the construction of this clamp may be had by rounding the under side of the clamping points *A*, as shown in Fig. 40. When a clamp with such rounded clamping points is placed in a position like that indicated in Fig. 39, it will practically bind the object to be held fully as firmly as if the two clamping surfaces were in the same plane.

TABLE VI. DIMENSIONS OF SHOULDER THUMB SCREWS.



A	B	C	D
3/16	9/16	1/2	3/32
1/4	1	11/16	1/8
5/16	1 1/8	3/4	5/32
3/8	1 1/4	13/16	5/32
7/16	1 1/2	15/16	3/16
1/2	1 5/8	1 1/8	3/16

The hole in these straps is very often elongated, as indicated by the dotted lines in Figs. 37 and 38. This allows the strap to be pulled back far enough so as to clear the work, making it easier to insert and remove the piece to be held in the jig. In some cases, it is necessary to extend the elongated hole, as shown in Fig. 41, so that it becomes a slot, going clear through to the end of the clamp, instead of being simply an oblong hole. Aside from this difference, the clamp in Fig. 41 works on exactly the same principle as the clamps previously shown. It is evident that the clamps described may be given a number of different shapes to suit different conditions. The screws used for clamping these straps are either standard hexagonal screws or standard collar head screws, dimensions

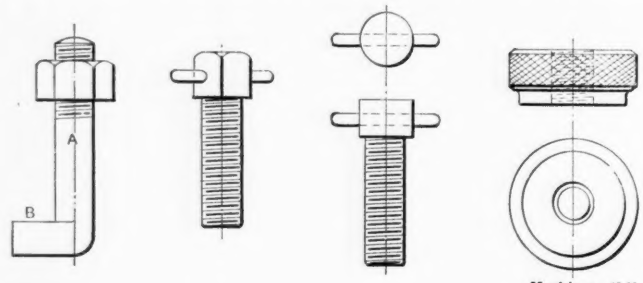


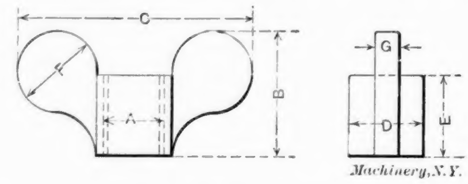
Fig. 43. Fig. 44. Fig. 45. Fig. 46.

of which latter are given in Table V. In a case where it is not necessary to tighten the clamps very much, shoulder thumb screws, as shown in Table VI, may be employed.

Instead of having the strap or clamp bear on only two points, it is sometimes necessary to have it bear on three points, in which case it may be designed similar to the strap shown in Fig. 42. In order to get an equal pressure on all the three points, a special screw, with a half-spherical head like the one shown, may be used to advantage. The half-spherical head of this screw fits into a concave recess of the same shape in the strap. When the bearing for the screw head is made in this manner, the hole through the clamp must have plenty of clearance for the body part of the bolt.

When designing clamps or straps of the types shown, one of the most important things to take into consideration is to provide enough metal around the holes, so that the strap will stand the pressure of the screw without breaking at the weakest place, which naturally is in a line through the center of

TABLE VII. DIMENSIONS OF WING OR THUMB NUTS.

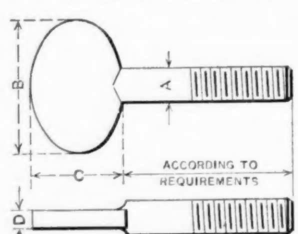


A	B	C	D	E	F	G
3/16	5/8	1 1/8	5/16	3/8	7/16	1/8
1/4	3/4	1 3/8	15/32	1/2	17/32	5/32
5/16	3/4	1 3/8	15/32	1/2	17/32	5/32
3/8	13/16	1 11/16	17/32	9/16	5/8	5/32
7/16	7/8	2	21/32	5/8	11/16	3/16
1/2	1 1/16	2 1/4	3/4	13/16	7/8	3/16

the hole. As a rule, these straps are made of machine steel, although large clamps may sometimes be made from cast iron.

The hook bolt shown in Fig. 43 is better adapted for some classes of work than any other clamping device. At the same time, it is very easy and cheap to make and easily applied. The bolt *A* passes through a hole in the jig, having a good sliding fit in this hole, and is pushed up until the hook or head *B* bears against the work, after which the nut is tightened. When great pressure is not required, the thumb or wing nut, such as shown, together with its dimensions, in Table VII, permits the hook bolt to be applied more readily. The thumb or wing nut is preferable to the knurled nut, shown in Fig. 46, which sometimes is used. It is possible to get a better grip, and to tighten the bolt more firmly by a

TABLE VIII. DIMENSIONS OF REGULAR THUMB SCREWS.



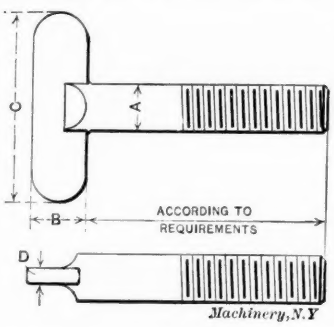
A	B	C	D
3/16	3/4	5/8	3/32
1/4	15/16	3/4	1/8
5/16	1 1/8	7/8	5/32
3/8	1 1/4	15/16	5/32
7/16	1 1/2	1 1/16	3/16
1/2	1 5/8	1 3/16	3/16

wing nut than it is with a knurled nut. When the work is removed from the jig, using the hook bolt clamping device, the nut is loosened, and the head or hook of the bolt is turned away from the work, thus allowing it to be taken out, and another piece of work to be placed in position. The hook bolts are invariably made of machine steel.

In a box jig, or a jig where the work is entirely, or almost entirely, surrounded by the jig, the work is easily held in place by set-screws and sometimes by screw-bushings. The set-screws are of different kinds, the most common being the standard square head set-screw, which is used whenever great clamping pressure is required, the square head allowing the use of the wrench. Sometimes screws of this kind may be tightened enough for the purpose by hand if a pin is put through the head of the screw, as shown in Figs. 44 and 45. This means is used not only when great pressure is not necessary, but also when the work is liable to spring if the screws are tightened too hard. In such a case, if a pin is inserted, it would be obvious that the screw head is not intended for a wrench, but that the pin is intended for getting a good grip by the hand for tightening the screw without

resorting to any additional means. Usually it is not possible to use an ordinary machine wrench on such a screw, as it generally is rather thin, so that if applied to the top of the screw, it would not permit a very good grip. Of course, a monkey-wrench could be applied, but it ought to be stated in this connection that a monkey-wrench ought not to be employed in ordinary manufacturing shop work, as it is intended

TABLE IX. DIMENSIONS OF THUMB SCREWS WITH WIDE GRIP.



A	B	C	D
3/16	1/4	7/8	3/32
1/4	5/16	1	1/8
5/16	3/8	1 1/4	5/32
3/8	7/16	1 1/2	5/32
7/16	1/2	1 3/4	3/16
1/2	9/16	2	3/16
9/16	5/8	2 1/4	3/16
5/8	11/16	2 1/2	7/32

primarily for jobbing work. More screws probably have been tightened too hard and twisted off by the injudicious use of a monkey-wrench than in any other way. When a monkey-wrench is used, it should be used with discretion. This, of course, does not mean to imply that the monkey-wrench is not one of the handiest tools that a machinist ever had in his possession, but it is intended to impress the idea that unless the monkey-wrench is used in such a manner that, when it is applied to a small screw head, the power applied at the end of the handle is in proportion to the screw, it is a risky tool to have around.

While a screw with a round head, as shown in Fig. 45, and with a pin put through the head, is undoubtedly better and

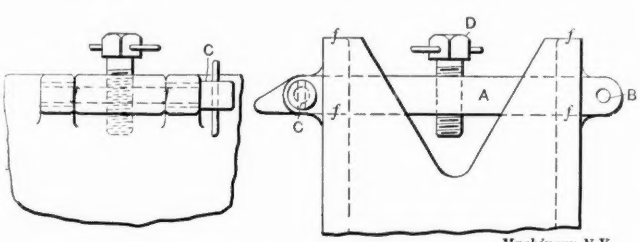


Fig. 47. Common Design of Leaf in Drill Jigs. Screw D Clamps the Work.

more convenient to use than the one shown in Fig. 44, the latter is cheaper to make, because standard screws can be taken right from stock, and a pin hole put through them, after the heads have been annealed. If thumb screws like the ones shown in Tables VIII and IX are available, they are preferable, as they give a good hold to the hand when they are tightened, and, besides, there is very little work required in finishing them. The use of a screw-bushing for clamping work has already been referred to. The clamping screws mentioned so far are generally applied directly onto the work, after having passed through the wall of the jig, or some projecting part serving as a seat for the screw.

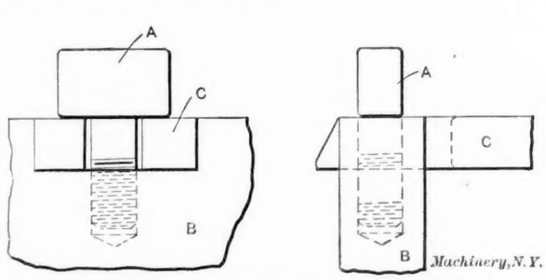


Fig. 48. Clamping Device for Leaf in Drill Jig.

Loose leaves which spring out, in order to permit the work to be inserted and removed, are usually constructed in some manner similar to that shown in Fig. 47, in which A represents the leaf, being pivoted at B and held by a pin at C, which goes through the two lugs on the jig wall and passes through the leaf, thus binding the leaf and allowing the tightening of the set-screw D, which bears against the work. The holes in the lugs of the castings are lined with steel bushings in order to prevent the cast iron holes from being worn out too soon by the constant pulling out and putting in of the pin. This kind of leaf, when fitted in nicely, is rather expensive, and is not only used for binding purposes, but also for guiding purposes, making a fitting seat for the bushings. If the leaves are fitted well in place, the bushing will guide the cutting tools firmly.

Another way of holding down the leaf is shown in Fig. 48, in which A is a thumb screw, screwed directly into the wall B of the jig, and holding the leaf C down, as indicated. To swing the leaf out, the thumb screw is turned back about a quarter of the turn, so that the head of the thumb screw stands in line with the slot in the leaf, this slot being made wide and long enough to permit the leaf to clear the head of the thumb screw. This is a very rapid way of clamping,

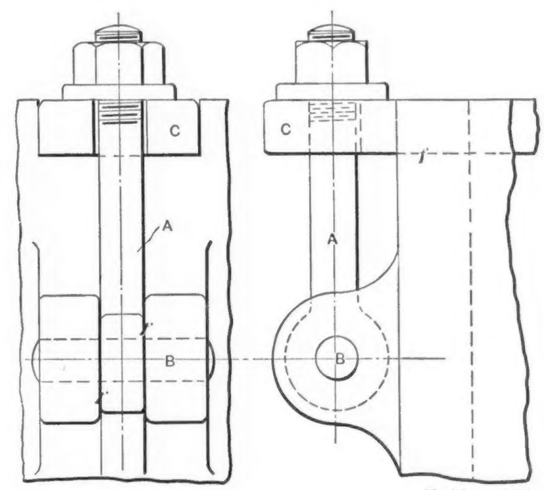


Fig. 49. Eye-bolt used for Clamping Drill Jig Leaf.

and is frequently used. The lower side of the head of the screw will wear a long time before the head finally comes in line with the slot when binding. It can then easily be fixed for binding the leaf again when standing in a position where the head of the thumb screw is at right angles to the slot, by turning off a portion of the head on the under side. The size of these thumb screws is made according to the strain on

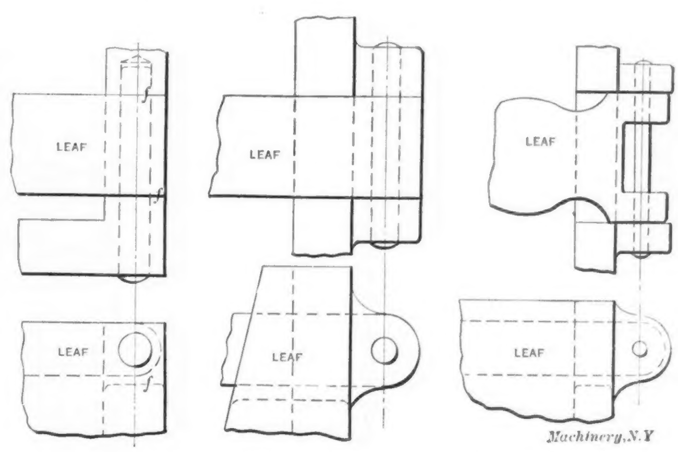


Fig. 50. Detail Designs of Joints between Leaf and Jig.

the leaf and the size and design of the jig. No standard dimensions could be given for this kind of screw.

The hinged bolt, shown in Fig. 49, is also commonly used. Here A represents an eye-bolt, which is connected with the jig body by the pin B. The leaf or movable part C of the jig is provided with a slot in the end for the eye-bolt, this slot being a trifle wider than the diameter of the bolt. The threaded end of the eye-bolt is provided with a standard hexagon nut, a knurled head nut or a wing nut, according to how firmly it is necessary that the nut be tightened.

When the leaf is to be disengaged, the nut is loosened up enough to clear the point at the end of the leaf, and the bolt is swung out around the pin B, which is driven directly into lugs projecting out from the jig wall, a slot being pro-

vided between the two lugs, as shown, so that the eye-bolt can swing out with perfect freedom. At the opposite end, the leaves or loose parts of the jig swing around a pin the same as in Fig. 47, the detailed construction of this end being, most commonly, one of the three types shown in Fig. 50. It must be understood that to provide jigs with leaves of this character involves a great deal of work and expense, and they are used almost exclusively when one or more guide bushings can be held in the leaf.

* * *

ADJUSTABLE LEVELING BLOCKS FOR PLANERS.

The adjustable leveling blocks shown in Figs. 1 and 2 are used in the shops of the Pratt & Whitney Co., Hartford, Conn., and the style shown in Fig. 1 is intended, in particular, for the planers made by the company. The design and action of these adjusting blocks are plainly shown in the engravings. The frame *A* is bolted to the concrete foundation by four anchor bolts *B* surrounded by pipes *C*, which prevent the concrete from coming in direct contact with the bolts, and permit a slight adjustment in longitudinal and sideways direction. At each end of the frame *A* are finished surfaces, planed to an angle of 15 degrees. On these surfaces slide the adjusting blocks *D*, also planed on the under side to a 15-degree angle, the upper side being level. These adjusting blocks or wedges are made of cast iron and provided with a long slot *E* permitting a lengthwise as well as a sidewise adjustment, the slot being two inches long and one inch wide, while the bolt, passing through it, is only ⅝ inch in diameter. The blocks are adjusted by set-screws *G*, provided with lock nuts. When properly adjusted, so that the planer table is level, the bolts

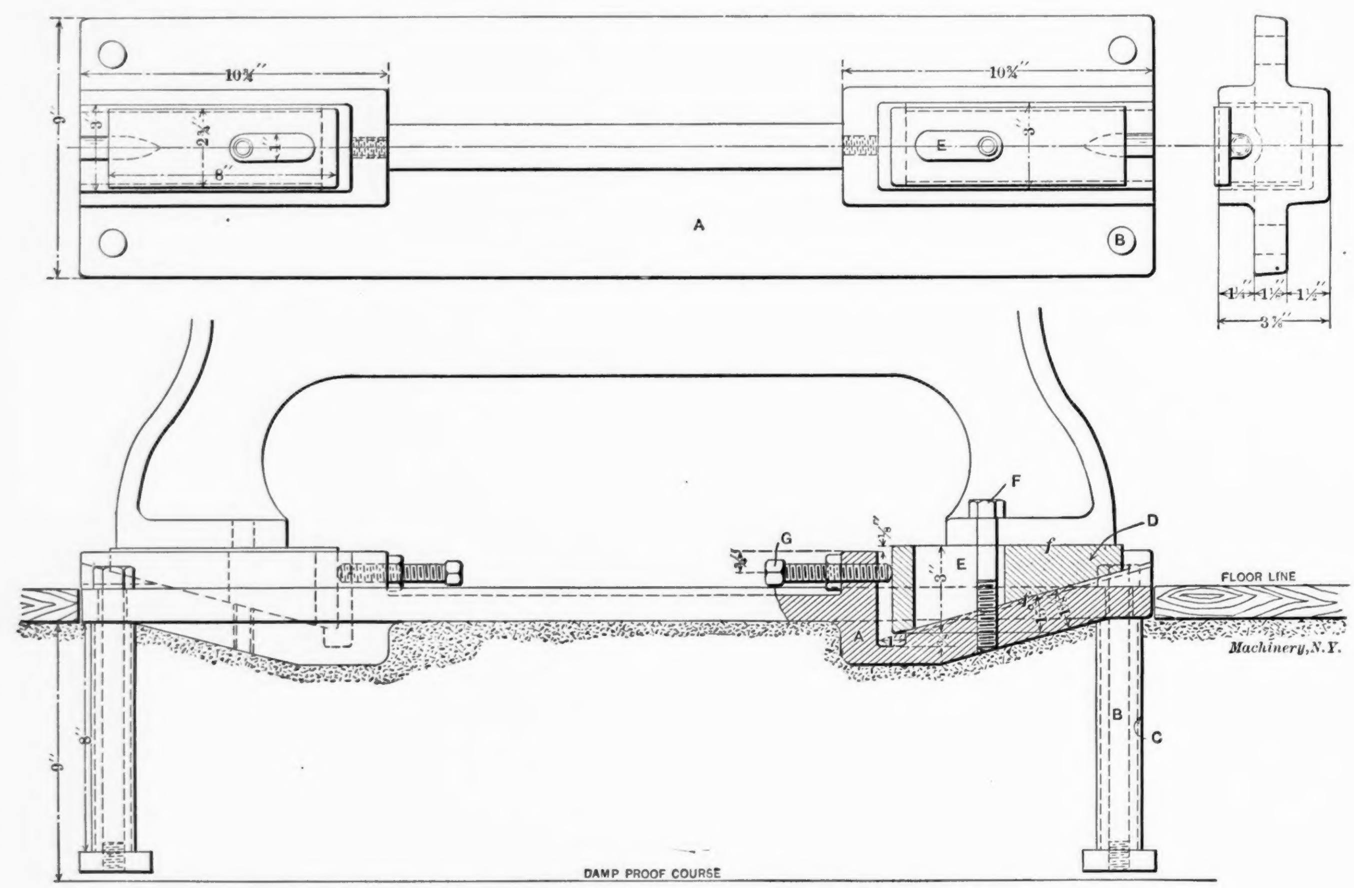


Fig. 1. Leveling Block for Planers, applied to a Pratt & Whitney Co. Planer.

F are tightened down, holding the planer firmly to the frame *A*, which itself is firmly embedded in the concrete foundation, and, as mentioned before, held down by the anchor bolts.

When the lower portion of the planer is of the construction shown in Fig. 1, so that it is possible to place the adjusting screws *G* on the inside, the frame and wedges are made so that the upper surface of the adjusting block will lift the planer table when pushed outward. On many planers, particularly those of larger sizes, it is not possible to have the adjusting screws on the inside, as they would be almost inaccessible. In such cases, the adjusting screw is placed as shown in Fig. 2, the frame and the adjusting block being reversed in their construction. The adjusting block is then pushed inward when it is desired to raise the leg resting upon it. With this exception, the principle of the adjusting block shown in Fig. 2 is exactly the same as that shown in Fig. 1.

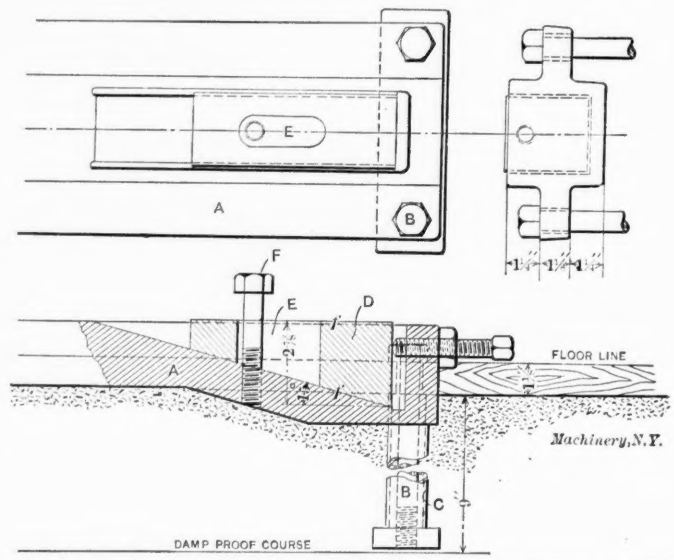


Fig. 2. Leveling Block with the Adjusting Screws on the Outside, instead of on the Inside, as in Fig. 1.

The frame *A* can be made in any length required by the length of the planer, the same pattern being used for all sizes, with the exception of lengthening pieces which are put in to make up for the required length over all. These leveling blocks have been found very convenient and suitable for the purpose for which they are used, and as there is allowance for adjustment in practically all directions, it is comparatively easy to get the desired results with this adjustable arrangement.

* * *

It is of the utmost importance that plants and machinery be maintained in a high state of efficiency. General recognition, however, is not given to another thing, which is of equal importance, namely, the maintenance of the operatives themselves in a high state of efficiency.—*Practical Engineer.*

SPECIAL AND ADJUSTABLE TAPS.

ERIK OBERG.*

STAYBOLT TAPS.

Staybolt taps are extensively used in locomotive boiler work. The ordinary or the radial staybolt tap is shown in Fig. 1; in Fig. 2 is shown the spindle staybolt tap, which has derived its name from the guiding spindle upon which the tap proper revolves.

Radial Staybolt Taps.

If we first give our attention to the radial staybolt tap, as shown in Fig. 1, the length *C* represents the threaded portion. Of this part, the portion *F* is straight or parallel, and the part *G* is chamfered. The part *E* is a taper reamer which reams the hole previous to tapping. The taper of this reamer is usually 3/32 inch per foot. The diameter at *H* is equal to the root diameter of the thread. The diameter of the shank is about 0.005 inch below the root diameter. Staybolt taps are usually made with 12 threads per inch, of the sharp

TABLE I. DIMENSIONS OF REGULAR STAYBOLT TAPS.

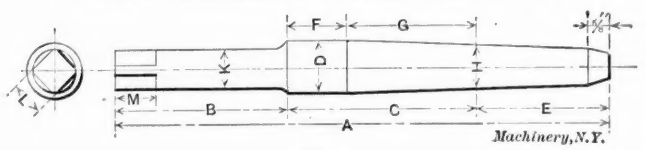


Fig. 1.

Total Length of Tap.	Diameter of Tap.	Length of Shank.	Length of Thread.	Length of Reamer.	Length of Parallel Thread.	Length of Chamfer.	Root Diameter.	Diameter of Shank.	Size of Square.	Length of Square.
A	D	B	C	E	F	G	H	K	L	M
20 inches.	3/4	7	7 1/2	5 1/2	1 1/2	6	0.606	0.601	15/32	3/4
	13/16	7	7 1/2	5 1/2	1 1/2	6	0.668	0.663	1/2	3/4
	7/8	7	7 1/2	5 1/2	1 1/2	6	0.731	0.726	9/16	3/4
	15/16	7	7 1/2	5 1/2	1 1/2	6	0.793	0.788	19/32	3/4
	1	7	7 1/2	5 1/2	1 1/2	6	0.856	0.851	21/32	1
	1 1/16	7	7 1/2	5 1/2	1 1/2	6	0.918	0.913	11/16	1
	1 1/8	7	7 1/2	5 1/2	1 1/2	6	0.981	0.976	3/4	1
	1 3/16	7	7 1/2	5 1/2	1 1/2	6	1.043	1.038	25/32	1
	1 1/4	7	7 1/2	5 1/2	1 1/2	6	1.106	1.101	27/32	1 1/4
	1 5/16	7	7 1/2	5 1/2	1 1/2	6	1.168	1.163	7/8	1 1/4
	1 3/8	7	7 1/2	5 1/2	1 1/2	6	1.231	1.226	15/16	1 1/4
24 inches.	3/4	9	8	7	2	6	0.606	0.601	15/32	3/4
	13/16	9	8	7	2	6	0.668	0.663	1/2	3/4
	7/8	9	8	7	2	6	0.731	0.726	9/16	3/4
	15/16	9	8	7	2	6	0.793	0.788	19/32	3/4
	1	9	8	7	2	6	0.856	0.851	21/32	1
	1 1/16	9	8	7	2	6	0.918	0.913	11/16	1
	1 1/8	9	8	7	2	6	0.981	0.976	3/4	1
	1 3/16	9	8	7	2	6	1.043	1.038	25/32	1
	1 1/4	9	8	7	2	6	1.106	1.101	27/32	1 1/4
	1 5/16	9	8	7	2	6	1.168	1.163	7/8	1 1/4
	1 3/8	9	8	7	2	6	1.231	1.226	15/16	1 1/4

V-form. Although practice has almost universally favored the employment of the sharp V-thread, the main advantage (and perhaps the only real advantage) of a thread of this kind is that it can be made tight in the boiler sheets and kept tight without any great difficulty. On the other hand, the use of the V-thread violates one of the fundamental principles of machine design—the principle, namely, of avoiding all sharp angles, and of filleting every place where such angles tend to occur. This must have occurred many times to engineers and designers, and yet no general movement has been made to discard the V-thread and substitute for it a form that shall not be open to the same objection. The Whitworth thread is receiving considerable attention at the present time, however, for use upon staybolts, and it is regarded with favor by certain builders of large experience, notably by the Baldwin Locomotive Works, which is now using this thread upon locomotive staybolts. If experience shows that staybolts can be made tight and kept so when fitted with this thread, it is probable that its adoption will extend to other builders.

Staybolt taps receive very rough treatment, and are exposed to hard usage, and should therefore be made of an extra good quality of steel. The thread should be relieved both on top and in the angle of the thread on the chamfered portion. The parallel portion of the thread is not relieved. In order to prevent having cutting edges which are too wide toward the smaller end of the chamfered portion, the tap is threaded taper about one-half of the chamfered part. This prevents

TABLE II. DIMENSIONS OF SPINDLE STAYBOLT TAPS.

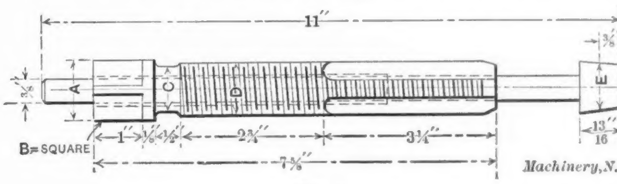


Fig. 2.

Diameter of Tap.	Diameter of Shank.	Size of Square.	Diameter of Neck.	Diameter of Guide.
D	A	B	C	E
3/4	1	3/4	0.601	5/8
13/16	1	3/4	0.663	11/16
7/8	1	3/4	0.726	3/4
15/16	1	3/4	0.788	13/16
1	1 1/16	13/16	0.851	7/8
1 1/16	1 1/8	7/8	0.913	15/16
1 1/8	1 3/16	7/8	0.976	1
1 3/16	1 1/4	15/16	1.038	1 1/16
1 1/4	1 5/16	1	1.101	1 1/8
1 5/16	1 3/8	1 1/16	1.163	1 3/16
1 3/8	1 7/16	1 1/16	1.226	1 1/4

the tap from reaming instead of cutting. In order to gain the same end, it is advisable never to make the chamfer any longer than, at most, 6 inches. The interrupted thread shown in Fig. 6 in the article on Taper Taps in the April issue, is particularly of value in the case of staybolt taps, and is probably used more on this class of taps than on any other.

TABLE III. DIMENSIONS OF STRAIGHT BOILER TAPS.

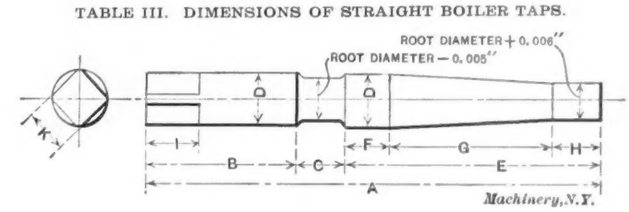


Fig. 3.

Diameter of Tap.	Total Length.	Length of Shank.	Length of Neck.	Length of Thread.	Length of Full Thread.	Length of Chamfer.	Length of Pilot.	Length of Square.	Size of Square.
D	A	B	C	E	F	G	H	I	K
1/2	4 1/4	1 3/4	1/2	2	1/2	1 1/8	3/8	1/2	3/8
9/16	4 7/16	1 13/16	1/2	2 1/8	9/16	1 3/16	3/8	9/16	7/16
5/8	4 5/8	1 13/16	1/2	2 5/16	5/8	1 1/4	7/16	5/8	15/32
11/16	4 13/16	1 13/16	9/16	2 7/16	11/16	1 5/16	7/16	11/16	1/2
3/4	5	1 7/8	9/16	2 9/16	3/4	1 5/16	1/2	3/4	9/16
13/16	5 3/16	1 15/16	9/16	2 11/16	13/16	1 3/8	1/2	13/16	5/8
7/8	5 3/8	2	9/16	2 13/16	7/8	1 7/16	1/2	7/8	11/16
15/16	5 9/16	2	5/8	2 15/16	15/16	1 1/2	1/2	15/16	11/16
1	5 3/4	2	5/8	3 1/8	1	1 9/16	9/16	1	3/4
1 1/16	5 15/16	2 1/16	5/8	3 1/4	1 1/16	1 5/8	9/16	1 1/16	13/16
1 1/8	6 1/8	2 1/16	5/8	3 7/16	1 1/8	1 11/16	5/8	1 1/8	7/8
1 3/16	6 5/16	2 1/16	11/16	3 9/16	1 3/16	1 3/4	5/8	1 3/16	7/8
1 1/4	6 1/2	2 1/8	11/16	3 11/16	1 1/4	1 3/4	11/16	1 1/4	15/16
1 5/16	6 11/16	2 3/16	11/16	3 13/16	1 5/16	1 13/16	11/16	1 5/16	1
1 3/8	6 7/8	2 1/4	11/16	3 15/16	1 3/8	1 7/8	11/16	1 3/8	1 1/16
1 7/16	7 1/16	2 1/4	11/16	4 1/8	1 7/16	1 15/16	3/4	1 7/16	1 1/16
1 1/2	7 1/4	2 1/4	3/4	4 1/4	1 1/2	2	3/4	1 1/2	1 1/8
1 5/8	7 5/8	2 5/16	3/4	4 9/16	1 5/8	2 1/8	13/16	1 1/2	1 1/4
1 3/4	8	2 3/8	13/16	4 13/16	1 3/4	2 3/16	7/8	1 1/2	1 5/16
1 7/8	8 3/8	2 1/2	13/16	5 1/16	1 7/8	2 5/16	7/8	1 1/2	1 7/16
2	8 3/4	2 1/2	7/8	5 3/8	2	2 7/16	15/16	1 1/2	1 1/2

In Table I the dimensions for standard radial staybolt taps, as made by a prominent tap manufacturing firm, are given. However, staybolt taps are made in a variety of sizes and designs for special requirements; but the two kinds given in the table are the most commonly used. All staybolt taps, of the

* Associate Editor of MACHINERY.

sizes given in the table, should have five flutes. The oversize limit of difference in diameter from the correct size of staybolt taps is commonly assumed to be 0.002 inch for taps smaller than 1 inch in diameter, and 0.003 inch for larger sizes. It is evident that it is not permissible for the tap to be *under* the correct size; consequently the diameter is required, after hardening, to be between the standard diameter and a diameter of 0.002 or 0.003 inch, respectively, above the standard.

Sometimes staybolt taps are provided with a threaded guide at the upper end of tne thread. This guide is not fluted and should be made slightly smaller in diameter than the cutting size of the tap. The amount which the diameter is smaller is usually about 0.010 inch, and should apply to the angle diameter as well as to the top of the thread. While not fluted, this threaded guide ought still to be grooved by a small convex cutter for oil passages to the flutes.

Spindle Staybolt Taps.

The spindle staybolt tap, as shown in Fig. 2, is not provided with a reamer, and with but a short chamfer. It is fluted about half the way of the threaded part. The remaining part of the thread acts as a guide, and should be made in the same way as threaded guides for radial staybolt taps. The guide E on the end of the spindle holds the tap in place in relation to the inner tube sheet, while the outer one is threaded. The standard dimensions for these taps are given in Fig. 2 and in Table II.

Straight Boiler Taps.

Straight boiler taps are, strictly speaking, only a special class of hand taps. They have a long chamfer, and a straight guide at the point. The chamfered portion is relieved on the top of the thread. These taps are fluted in the same way as hand taps. In Table III the dimensions for these taps are given. The most important of these dimensions are determined from the formulas:

$A = 3D + 2\frac{3}{4}$ inches,

$E = 2\frac{1}{4}D + \frac{7}{8}$ inch,

$F = D$,

$H = \frac{3}{8}D + 3/16$ inch,

in which formulas

A = total length of tap,

D = diameter of tap,

E = length of threaded portion,

F = length of full or parallel thread, and

H = length of guide.

In making these taps the same limits in regard to oversize diameters as employed for regular hand taps should be adopted. (See MACHINERY, July, 1907: Remarks on the Making of Hand Taps.)

Straight Pipe Taps.

Straight pipe taps are only a variation of hand taps, but have the same number of threads per inch as the corresponding sizes of taper pipe taps, and a diameter arbitrarily adopted by the manufacturers of these taps. Table IV gives the dimensions for taps up to and including 3/4 nominal diameter. The larger sizes are given in Table V. It will be noticed that the difference in appearance between the larger and smaller sizes is simply that the latter is provided with a short neck, turned down below the root diameter, while on the larger sizes the whole shank is turned down below the root of the thread.

These taps are chamfered the same as plug hand taps, and relieved only on the top of the thread on the chamfered part.

TABLE IV. STANDARD STRAIGHT PIPE TAPS.

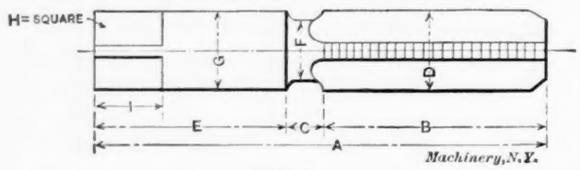


Fig. 4.

Nominal Size.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Neck.	Length of Shank.	Diameter of Neck.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G	H	I
1/8	0.398	2 5/8	1	5/16	1 5/16	0.335	3/8	9/32	7/16
1/4	0.531	2 7/8	1 1/8	3/8	1 3/8	0.440	1/2	3/8	1/2
3/8	0.672	3 1/16	1 1/4	3/8	1 7/16	0.575	5/8	15/32	9/16
1/2	0.828	3 1/4	1 3/8	7/16	1 7/16	0.705	3/4	9/16	5/8
3/4	1.041	3 5/8	1 5/8	1/2	1 1/2	0.915	1	3/4	3/4

TABLE V. STANDARD STRAIGHT PIPE TAPS.

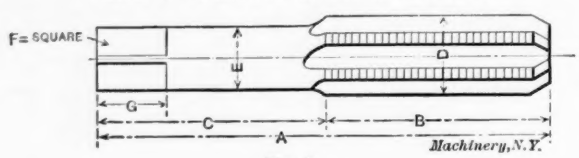


Fig. 5.

Nominal Diameter.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Shank.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G
1	1.293	4	1 3/4	2 1/4	1 1/8	13/16	13/16
1 1/4	1.645	4 7/16	1 15/16	2 1/2	1 1/4	15/16	15/16
1 1/2	1.880	4 7/8	2 1/8	2 3/4	1 3/8	1 1/16	1
2	2.359	5 11/16	2 7/16	3 1/4	1 5/8	1 1/4	1 3/16
2 1/2	2.836	6 1/2	2 3/4	3 3/4	1 7/8	1 7/16	1 5/16
3	3.461	7 3/8	3 1/8	4 1/4	2 1/8	1 5/8	1 1/2
3 1/2	3.971	8 3/16	3 7/16	4 3/4	2 3/8	1 13/16	1 11/16
4	4.398	9	3 3/4	5 1/4	2 5/8	1 15/16	1 13/16

TABLE VI. ENGLISH STRAIGHT PIPE TAPS.

(See Fig. 4 for meaning of letters in table.)

Nominal Size.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Neck.	Length of Shank.	Diameter of Neck.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G	H	I
1/8	0.385	2 5/8	1	5/16	1 5/16	0.335	3/8	9/32	7/16
1/4	0.520	2 7/8	1 1/8	3/8	1 3/8	0.448	1/2	3/8	1/2
3/8	0.665	3 1/16	1 1/4	3/8	1 7/16	0.593	5/8	15/32	9/16
1/2	0.822	3 1/4	1 3/8	7/16	1 7/16	0.726	3/4	9/16	5/8
5/8	0.902	3 7/16	1 1/2	7/16	1 1/2	0.806	7/8	21/32	11/16
3/4	1.034	3 5/8	1 5/8	1/2	1 1/2	0.938	1	3/4	3/4

TABLE VII. ENGLISH STRAIGHT PIPE TAPS.

(See Fig. 5 for meaning of letters in table.)

Nominal Size.	Diameter of Tap.	Total Length.	Length of Thread.	Length of Shank.	Diameter of Shank.	Size of Square.	Length of Square.
	D	A	B	C	E	F	G
7/8	1.189	3 13/16	1 11/16	2 1/8	1 1/16	13/16	13/16
1	1.302	4	1 3/4	2 1/4	1 1/8	13/16	13/16
1 1/8	1.492	4 1/4	1 7/8	2 3/8	1 3/16	7/8	7/8
1 1/4	1.650	4 7/16	1 15/16	2 1/2	1 1/4	15/16	15/16
1 3/8	1.745	4 11/16	2 1/16	2 5/8	1 5/16	1	15/16
1 1/2	1.882	4 7/8	2 1/8	2 3/4	1 3/8	1 1/16	1
1 5/8	2.021	5 1/16	2 3/16	2 7/8	1 7/16	1 1/16	1 1/16
1 3/4	2.047	5 5/16	2 5/16	3	1 1/2	1 1/8	1 1/16
1 7/8	2.245	5 1/2	2 3/8	3 1/8	1 9/16	1 3/16	1 1/8
2	2.347	5 11/16	2 7/16	3 1/4	1 5/8	1 1/4	1 3/16
2 1/8	2.467	5 7/8	2 1/2	3 3/8	1 11/16	1 1/4	1 3/16
2 1/4	2.587	6 1/8	2 5/8	3 1/2	1 3/4	1 5/16	1 1/4
2 3/8	2.794	6 5/16	2 11/16	3 5/8	1 13/16	1 3/8	1 5/16
2 1/2	3.001	6 1/2	2 3/4	3 3/4	1 7/8	1 7/16	1 5/16
2 5/8	3.124	6 3/4	2 7/8	3 7/8	1 15/16	1 7/16	1 3/8
2 3/4	3.247	6 15/16	2 15/16	4	2	1 1/2	1 7/16
2 7/8	3.367	7 1/8	3	4 1/8	2 1/16	1 9/16	1 7/16
3	3.485	7 3/8	3 1/8	4 1/4	2 1/8	1 5/8	1 1/2
3 1/4	3.698	7 3/4	3 1/4	4 1/2	2 1/4	1 11/16	1 9/16
3 1/2	3.912	8 3/16	3 7/16	4 3/4	2 3/8	1 13/16	1 11/16
3 3/4	4.125	8 5/8	3 5/8	5	2 1/2	1 7/8	1 3/4
4	4.339	9	3 3/4	5 1/4	2 5/8	1 15/16	1 13/16

The number of flutes may be made the same as for corresponding sizes of Briggs' standard pipe taps (see MACHINERY, March, 1908: Taper Taps); if it is considered that less flutes would be more advisable, approximately the same number of flutes as is given to regular hand taps will be satisfactory. In cases like this the number of flutes, within reasonable limits, is largely a matter of judgment. The straight pipe tap, being actually a hand tap, should evidently be fluted like a hand tap. But inasmuch as the tap has a greater number of threads per inch than corresponding sizes of ordinary hand

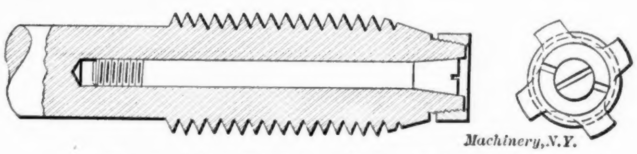


Fig. 6. Adjustable Tap made from Solid Stock.

taps, there is a reason for providing it with a greater number of flutes. English pipe taps, having Whitworth form of thread, and made according to Whitworth's thread system for gas and water piping, are given in Tables VI and VII.

Adjustable Taps.

Adjustable taps are made for the purpose of permitting adjustment to a correct standard size. As the solid tap, on account of changes in hardening, cannot be depended upon to measure exactly the diameter for which it was intended, and because of the impossibility of preventing a tap from decreasing in diameter through wear, the adjustable tap has a wide field of usefulness where correct size nuts must be produced. The adjustable tap may either be made from a solid piece,

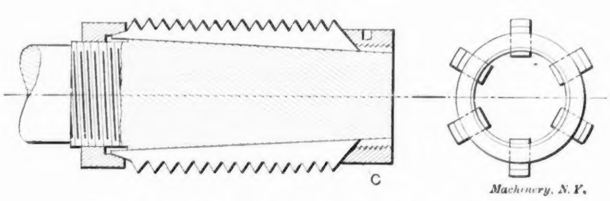


Fig. 7. Adjustable Tap with Inserted Blades.

split in a suitable manner to permit adjustment, or may be provided with inserted blades or cutters, which are so held in the tap body that a slight movement of these blades in the longitudinal direction of the tap moves the cutting points of the thread nearer or farther from the axis of the tap, thus decreasing or increasing the diameter, as the case may be.

Another cause for inserted blade taps other than adjustability may also be mentioned. The efforts constantly made by progressive manufacturers to decrease the cost of tools without impairing their efficiency, have resulted in the design of a number of taps of this type, which permit a cheaper grade of material to be used in the tap body, while the best quality steel may be used for the inserted blades, the total

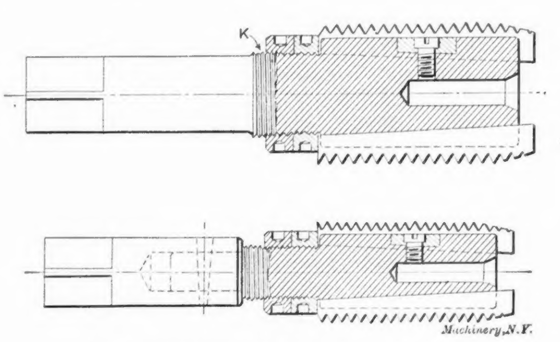


Fig. 8. Improved Design of Adjustable Tap.

cost, especially in the case of large taps, being smaller than if the tap were made solid of ordinary tool steel throughout. Incidentally another advantage is also gained. Inasmuch as the cutting portion of the tap is the only one which, in general, when worn, has caused the tap to be discarded, the inserted blade design makes it possible to retain the body proper and replace the cutters only.

In the case of large taps and coarse pitches, the adjustable tap does not give very good satisfaction if a thread is cut by one passage of the tap, because the strain on the tap is so great as to spring it to a certain extent. It is evident that an adjustable tap cannot possibly be made fully as rigid as a solid tap. But in such cases the tap still retains its superiority as a "sizing" tap, used to finish the thread after it has been roughed out by means of an ordinary tap somewhat under size.

Examples of Adjustable Taps.

The form of adjustable tap, previously referred to, which is cut from a solid piece and split, is shown in Fig. 6. The body is split straight through, a nut with a taper thread serves to hold the tap together at the end, and a screw with a taper head is used to expand the tap, as shown. As the expansion is effected by bending the cutting lands when the tapered head of the screw travels inward, the thread form is not accurately retained, and the tap is not to be recommended. When accurate work is required, the inserted blade form of adjustable taps is the preferable form. The requirements for a good inserted blade tap are that the blades when bound in place shall be practically solid with the body, that the design shall permit a liberal adjustment in regard to size, that this adjustment shall be easily accomplished, and that the means employed for binding and adjusting the blades shall not be of such a kind as to prevent the use of the tap in any case where the solid tap could be used. This latter requirement involves the possibility of tapping clear through a hole as well as the tapping down to the bottom of a hole.

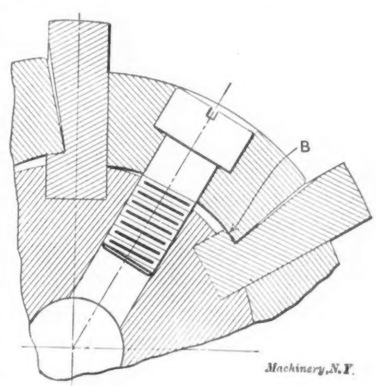


Fig. 9. Method of Binding the Blades in Tap, Fig. 8.

A tap which fills fairly well all these requirements, with the exception of the one mentioned last, is shown in Fig. 7. The blades are held in place by nuts, beveled on the inside to fit the tapered ends of the blades. In this manner the blades are prevented from longitudinal motion as well as from moving out or in in relation to the center line of the tap. The blades fit into slots in the tap body and are thus prevented from moving sideways. The adjustment is provided for by the tapered bottom of the slots in the body, by means of which the cutting size of the tap increases when the blades

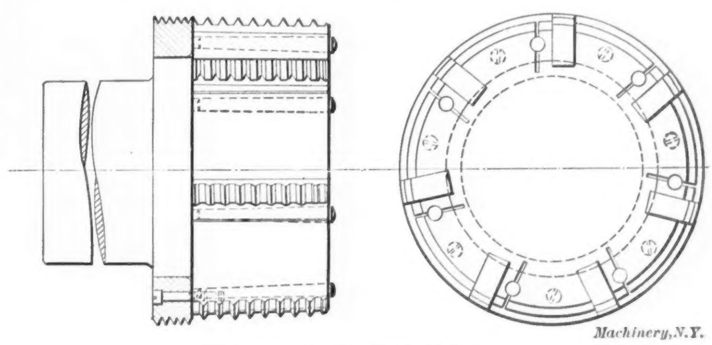


Fig. 10. Inserted Blade Pipe Tap.

are moved upward toward the shank end of the tap. The adjustment is easily accomplished, it only being required to loosen the upper nut and push up the blades, and then tighten the lower as well as the upper nut solidly upon the blades. It is, however, not possible with the design shown to tap down clear to the bottom of a hole, nor is it possible to tap straight through a hole. This latter requirement could, of course, easily be obtained by making the slots deeper and the blades wider, thus making it possible to decrease the outside diameter of the upper binding nut so that it would be less than the root diameter of the thread. This would permit the tap to pass through a threaded hole. There is, however, a more serious objection to this design. The backing of the blade by means of a tapered surface in the nut is not very positive, and the blades are liable to be a trifle incorrect in their relative posi-

tion in regard to lead. It is evident that if that is the case the thread cut will be incorrect in its shape, the space cut in the nut being wider than the thread itself. A tap which overcomes the objections raised in regard to the tap in Fig. 7 is shown in Fig. 8. The construction of this tap was described in the July, 1907, issue of MACHINERY, in an article entitled Adjustable Reamers and Taps with Inserted Blades. In this article the reasons for the superiority of the design of taps and reamers made as indicated in Fig. 8 were stated, and it is unnecessary to repeat this discussion here. Those who may not have read the article in question can easily see the principle of the design from the sectional view of the tap, Fig. 9, which shows the principle employed for binding the blades very clearly.

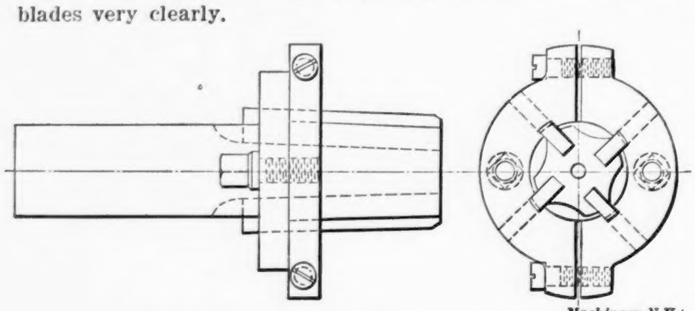


Fig. 11. Another Design of Inserted Blade Pipe Tap.

Inserted blade taps are not adapted to very small sizes. As a rule, it should not be attempted to make such taps in sizes smaller than 1½ inch, or, at least, not below 1¼ inch in diameter.

Other Examples of Inserted Blade Taps.

In Fig. 10 an inserted blade tap, of a design common for pipe taps, is shown. Here the chasers are held in place by means of taper pins, which wedge the metal of the body firmly against the blade. The correct location of the blades in a longitudinal direction is obtained by means of a ring, held to the body by screws. It is plainly seen from the construction that this tap is not intended to be adjustable, but is simply made with inserted blades from an economical point of view. This design which is most commonly used for large taps, affords a considerable saving in material. The tap shown in the engraving is provided with interrupted thread, as frequently used on pipe taps, and taper taps in general.

Another form of inserted blade tap is shown in Fig. 11. The blades are here held in place by means of a ring threaded on the inside to fit the thread of the blades or chasers, and split and provided with binding screws so as to make possible a positive grip over the blades. The advantage of this design is that the threads of the various chasers must necessarily be so located as to form a continuous helix all around the tap, inasmuch as the threaded ring fits upon the thread in the chasers. But the design is open to the objection that the ring prevents threading as far down in a hole as may sometimes be required, and the ring may interfere with lugs or projections on the piece to be threaded. In this respect the former of the two taps last described is superior, as it is free from any outside incumbrance, and takes up no more room than a solid tap.

* * *

THE TOOL ROOM VERSUS THE MACHINE SHOP SHAPER.

WILLIAM ECKER.*

A shaper for tool-room use can never answer its purpose with economy if used for regular machine shop work, as it cannot retain its accuracy when subjected to the strains and hard knocks common in machine shop practice. A tool-room shaper should not be expected to rush out work with heavy cuts, as this leads to distortion of the working parts, and constitutes an abuse of the machine. A reasonable cut indicates judgment.

The tool-room shaper should be well graduated on all screws used for adjustment in practical tool work; such graduations, if reliable, are more convenient for use than measurements made by scale or caliper. A first-class mechanic will have a great respect for a tool that is graduated and reliable, because this eliminates all guess work, and relieves the worker of anxiety, as he depends on the machine to produce the work correctly. "The smile that won't come off" is on both the tool-maker's and the apprentice's face when he takes a piece of work out of the shaper vise and finds it square and parallel; that smile, however, is never seen on the face of the man using the machine shop shaper, but only a look of anxiety, for he works by "guess." He knows his shaper is not true; consequently more cuts and calipering, with final filing and scraping, all of which is not economical. Filing and scraping in a first-class tool-room, after machining a piece of work, is only a indication that the work has been done on a poor machine, or in a hurry and not deliberately, and causes loss of time amounting to, perhaps, four times the time required for machining the work over again, and still not producing so good looking a job when inspected by a capable judge. To sum up, while graduations are desirable on the adjusting screws, if they are out of true, they are only confusing; for this reason few machanics use them even when they exist, because they have lost confidence in the machine.

The feed on a tool-room shaper is usually one, two, or three teeth. Rather than to use a heavier feed, the tool-maker, when cutting tool steel, may adjust the machine to take a deeper or shallower cut. The tool-room shaper does not require so large a range as is required by the machine shop shaper, and can, therefore, be designed along lines leading towards rapid and convenient manipulation, and more compact and rigid construction. The class of people the best tool-makers come from are generally thin, nervous and very sensitive, and a heavy and clumsy design does not appeal to them at all, but produces a feeling of antagonism. As they are the ones who have to use the machine, they are in general, the best judges of the machine. The standard of a tool-room is always greatly influenced by the standard of tools used, for even a good, first-class workman will grow indifferent, if indifferent tools are to be used.

The machine shop shaper, as considered apart from the tool-room shaper, is generally called upon to do a great variety of work, and must be designed with more liberal proportions, and is not so well adapted to perform small, reliable, exact operations; "snagging" and "hogging" is considered quite the proper thing with this tool. This always produces the same result. The machine will not long remain reliable, and consequently there is a great deal of measuring, calipering, squaring and swearing, all multiplied four times by waste of time. In the machine shop practice, the work to be done calls for a greater variety of feeds than a tool-maker usually demands. The machine shop shaper is also often in the care of workmen of inferior training. This fact always influences the design of the machine and leads toward clumsiness, which is the opposite of the tool-room shaper.

On account of these differences between the tool-room shaper and the machine shop shaper, it is reasonable to assume that the design fitted for tool-room purposes is not suitable for the machine shop. Therefore, we should have a tool-room shaper built for the purpose of tool making, and a machine shop shaper for machine shop purposes. This difference cannot be denied, or all claims for specializing machinery must be renounced. "Happy mediums" are sometimes good, but should be called so, and there are very few of them at present.

A suggestion in the designing of shapers which may not be out of place is that on account of the fact that in any make of shaper the ram has considerable weight, and travels at a comparatively high speed, it would only be reasonable to make an attempt at counterbalancing, having the same kind of springs or shock absorbers as usual in some other kinds of machinery, to take up the shock at the end of the stroke.

* * *

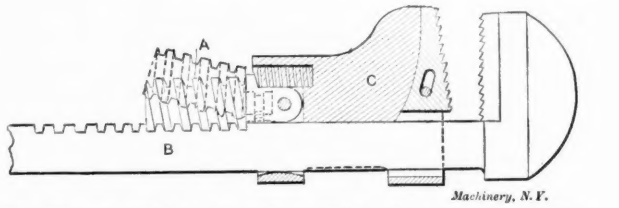
Steel wool is a by-product much used by wood finishers, painters, etc., in preference to sandpaper, especially on molded work. It is the long, hair-like chips produced in drilling rifle barrels. A curious commercial fact about this product is that it sells for several times the cost of the steel composing the barrels, the retail price being about 50 cents per pound.

* Address: Gould & Eberhardt, Newark, N. J.

ITEMS OF MECHANICAL INTEREST.

QUICK-ADJUSTMENT PIPE WRENCH.

The accompanying engraving shows an interesting pipe wrench made on the monkey-wrench principle and patented by Mr. M. G. Ewer, of Detroit, Mich. The principal feature of this wrench is its quick adjustment to various sizes of pipe. It will be seen that the binding or adjusting screw *A*, which engages with the thread cut in the handle *B* of the wrench, is pivoted to the movable jaw *C*, and when it

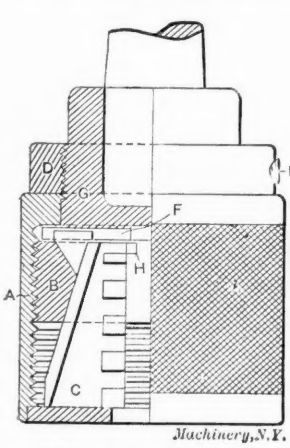


Pipe Wrench which is adjusted quickly by disengaging Adjusting Screw, as shown by the Dotted Lines.

is required to move this jaw a long distance out or in, the adjusting screw is simply lifted out of engagement with the thread on the shank as shown by the dotted lines, and the jaw is slid along the shank until it has approximately reached the location required. Then the screw is pushed into engagement with the thread on the shank, and the final adjustment and clamping are made as usual.

A NEW DRILL CHUCK.

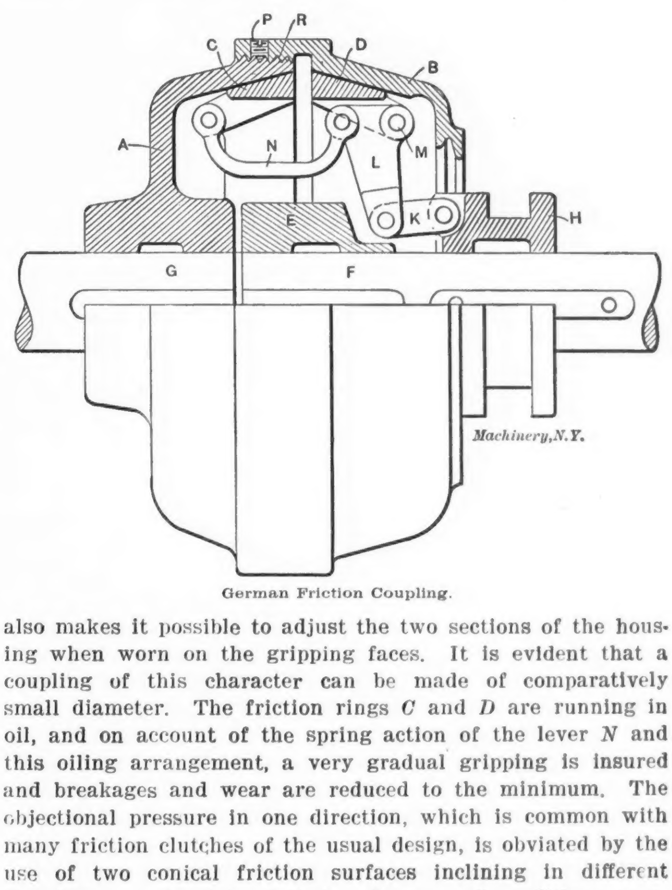
A drill chuck, embodying an interesting feature, whereby the drill is clamped more firmly in the chuck as the pressure on the cutting tool increases, has been designed by Mr. P. G. Lagerbäck, of Aktiebolaget Nordiska Artilleriverkstäderna, Finspong, Sweden. The following description of this drill chuck is abstracted from *Industritidningen Norden*. The sleeve *A* is threaded on the inside and engages with the chuck ring *B*, provided with grooves for receiving the chuck jaws *C*. The sleeve *A* is prevented from lateral motion by the nut *D*, provided with binding screw *E* for holding it in place. The jaws are provided with a projection *F*, which enters in a groove in the chuck holder *G*. When the sleeve *A* is turned in relation to the holder *G*, the jaws *C* and consequently the chuck ring *B*, are thus prevented from taking part in this rotary motion, and consequently the chuck ring *B* will move in a lateral direction, thereby closing the chuck jaws on, or releasing them from the tool shank. A small projection *H* is provided on each of the jaws, and the end of the tool shank rests against this projection. The length of the jaws is slightly less than the place within the chuck provided for them, so that after having been clamped upon the tool shank, when the pressure is applied on the tool, the end of the tool shank will press on the projections *H*, thereby having a tendency to force the jaws upward, and this, in turn, will clamp the tool more firmly in the chuck, inasmuch as the jaws, in order to move upward, will also be forced inward by the taper on their back surface.



Drill Chuck which clamps Tool more firmly as Pressure Increases.

FRICTION COUPLING OF SIMPLE DESIGN.

Judging by the great number of different designs of friction couplings placed on the market during the last year, it seems as if special energy had been devoted to the design of simple and efficient friction couplings in Germany. We have illustrated several of these designs in the columns of MACHINERY during the past year. The accompanying engraving shows another design which, in regard to simplicity, probably excels most of the others. This coupling is manufactured by the Sächsische Maschinenfabrik, Chemnitz, Germany. As seen in the engraving, this coupling consists of a housing made in two sections *A* and *B*. The inside of this housing is made tapered from the center, and friction rings *C* and *D* transmit the motion from this housing to a central hub *E*, which in turn is keyed to the shaft *F*. The housing itself is keyed to the shaft *G*, power being thus transmitted from the shaft *G* to the shaft *F*. The friction rings *C* and *D* are operated through a lever mechanism from the sleeve *H*, which in turn is operated by a fork bolted to the shifting lever. The sleeve is connected through link *K* with the lever *L* which is pivoted at *M*. The link *N* connects the two friction rings *C* and *D*, and according to the position of the lever *L*, the rings will be pressed against the housing or released from it. On account of the shape of the link *N* a certain spring action is possible in this member. It will be noted that the two sections *A* and *B* of the housing are connected with each other through the threaded portion at *R*, a set-screw *P* being used for binding the part *B* to the part *A* after being adjusted. This threaded joint permits of a very close adjustment of the two halves of the housing so that the tapered surfaces on the inside can be placed in such positions as to insure a binding action at exactly the place required by the position of the levers. It



German Friction Coupling.

also makes it possible to adjust the two sections of the housing when worn on the gripping faces. It is evident that a coupling of this character can be made of comparatively small diameter. The friction rings *C* and *D* are running in oil, and on account of the spring action of the lever *N* and this oiling arrangement, a very gradual gripping is insured and breakages and wear are reduced to the minimum. The objectional pressure in one direction, which is common with many friction clutches of the usual design, is obviated by the use of two conical friction surfaces inclining in different directions. It is claimed that under normal conditions couplings of this type can be used to advantage for shafts up to about 5 inches diameter. Upon examination of the lever arrangement it will be found that the coupling cannot accidentally release inasmuch as the levers are arranged to give a kind of toggle action so that when lever *L* once comes into position where it clamps the friction rings to the housing it cannot again release, unless considerable force is applied at its lower end from sleeve *H* through the link *K*. In a design of this kind there are, of course, normally two or four sets of links of the same kind as the one set shown in the sectional part of the engraving.

* * *

A FEAT OF HALF-TONE ILLUSTRATION IN JOURNALISM.

Here is the record of the latest feat of half-tone illustration in journalism. A New York daily newspaper photographed the finish of the Brooklyn handicap at Gravesend, L. I., race track, June 1, at 4 o'clock, carried the negative in an automobile to Herald Square, developed it, made a half-tone plate, electrotyped it and placed printed papers containing the illustration on the street at 6 o'clock that night.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

SELF-OILING MACHINERY.

We believe that if there is one great improvement in modern machinery and machine tools that should be extolled beyond all others, it is the self-oiling feature that is being used on high-grade high-speed steam engines and certain machine tools. It seems, when one reflects on it, that many manufacturers must have been asleep to be content to go along year after year building and using machines that require the continual attention of the operator's oil-can. The common attitude of indifference among machinists and machine builders to self-oiling machines doubtless is largely because of early education. About the first thing that an apprentice or machine tender is taught is to keep his machine well oiled. Oiling his machine regularly becomes part of his mental make-up and it is something of a shock to his ideas of the fitness of things to see and use highly developed machinery that requires no attention whatever from the oil-can. We must get away from the antiquated idea that each and every bearing requires individual inspection and oiling two or three times a day, for there is no good reason why a machine should not oil itself. To be sure, the first cost of such machinery is more, but the difference is negligible when the advantages are considered. The mechanical efficiency may be increased so much as to save in power the extra cost of the improved oiling facilities in the first six months. Bearings carrying comparatively light loads will run indefinitely with no perceptible wear if they are continually oiled. Then there is the item of cleanliness which alone makes the self-oiling feature worth adoption in shops that require all machines to be kept in a cleanly condition.

* * *

OBSOLETE TOOLS IN MACHINE TOOL SHOPS.

Machine tool builders are interested directly and indirectly, more than any other manufacturers, in promoting the general use of up-to-date labor-saving machinery; yet the experience of one who has visited a large number of works indicates that the best equipped machine shops are sometimes *not* those engaged in the building of machine tools. The demand for nearly all new machine tools depends largely on the ability of the seller to demonstrate their economy in production over preceding types; yet we have noticed in some machine tool shops obsolete machines that occupy valuable space and waste a large part of the operator's time because of their inefficient productive capacity. Think of the effect of such examples on a possible purchaser who is being taken through a shop containing such tools—not to speak of the result of this policy on ultimate profits as well as on the progress of the shop and the development of its product.

This is a good time for each machine tool builder to take stock of his own equipment and decide what machines are unprofitable or can be replaced by others that will yield a good return on the investment and perhaps raise the standard of the product by their superior work. Although no manufacturers can live by "cutting each other's hair," the machine tool builders can help one another considerably just now by installing some of the valuable machines built by their contemporaries. Such purchases will greatly increase the general efficiency of American machine tool shops and prove a welcome addition to the order books of most manufacturers. Both buyers and manufacturers can take the time now to ensure the right tools being installed for the work required, which may not be the case three months from now.

* * *

BACK TO FIRST PRINCIPLES IN STOCK-KEEPING.

Years ago when the building of machines was conducted in a primitive manner, stock-rooms under the charge of responsible persons were practically unknown, and the small parts needed in construction work were commonly produced as they were needed. This applied to castings, bolts, screws, nuts, shafts, pulleys and all other parts that are now commonly made up into stock and used as required. Then followed the period when small parts were manufactured and kept in a stock-room to be issued only upon requisitions made by the foremen or other responsible employes. This system naturally followed the discovery that it was cheaper to manufacture parts than to make them one by one when needed. The requirements of bookkeeping and economical administration apparently made the store-room system a necessity to avoid the losses that would follow where employes were free to help themselves to finished parts. So obvious is this proposition that to keep stock parts worth thousands of dollars in open bins in the shop, freely accessible to workmen, seems a rank heresy, but that is exactly the present practice of a number of western machine tool builders who have followed it for some time with much success. In the manufacture of drill presses, lathes, etc., it is possible to make large quantities of small gears, pulleys, handles, knobs, spindles, pinions, clutches, tool-posts, worms, worm-wheels, etc., at low cost per piece, but if they are stored in a stock-room and given out only on requisitions, there is a chance that a considerable part of the saving made possible by the system of manufacture will be lost because of time wasted by men waiting for these parts and the time consumed by foremen and storekeepers in attending to these wants.

Where the parts are freely accessible, each man helps himself, under the supervision of the sub-foreman, of course, who sees that no parts are wantonly wasted. It saves time and promotes rapid work. There is little incentive to purloin these parts as they are of practically no value to individuals, being made of iron and steel. Of course, in the case of parts made of brass or other intrinsically valuable metal the system would hardly be practicable, nor would it be feasible, perhaps, for such parts as might be applied to mechanical uses outside of the designed use.

A saving of considerable importance in shops where space is at a premium is the abolition of the large store-room. The parts to be readily accessible should be in the erecting shop, and it is usually possible to utilize space under benches or by the walls, that is of little value for other purposes. This factor alone might sometimes be a deciding one in the adoption of the "open shop" store-room plan.

* * *

Imitation indicates limitation.—*The Silent Partner.*

THE PERSONNEL OF WORKMEN.

The "Confidences of a Manufacturer" (see November, 1907, issue) enunciated one principle that has been applied, by at least a few manufacturers, with great profit to themselves and their employes. It is a principle that foremen should understand and foster, as it will tend to make the management of their departments easy and successful.

The principle is simply to hire new help, so far as possible, only upon the recommendation of old employes. Of course, good judgment must be exercised to prevent the formation of parties or cliques, and that is exactly what the system will discourage if rightly directed. If a new man is hired upon an employe's recommendation, that employe feels a certain responsibility in his success, and will help the stranger to make good, instead of discouraging him at the outset, as he might do under different circumstances.

A man of good habits and a master of his trade is not likely to recommend a man of bad habits or one who is incompetent, and while trade union influences may change all this in certain cases, in general it will apply. The plan has proved successful in the employment of girls in manufacturing.

* * *

LIMITATION OF AUTOMATIC MACHINERY.

Notwithstanding the great development of automatic machinery, there yet remains a large number of mechanical operations for doing which no automatic machinery has been developed that can compete successfully with hand-operated machines, especially in the machine tool field. The manufacturers of brass valves and other brass goods use hand-operated lathes almost exclusively for turning, boring and threading spindles, caps, stuffing-boxes, bodies, collars, studs, etc. These manufacturers, of course, are keenly anxious to displace manually-operated machines wherever they can do it profitably, but little automatic machinery has been developed, so far, that is as efficient in operation and that does not cost far more for up-keep. The operators of brass lathes become so expert that the time required for some operations is but little more than that required for picking up the piece, chucking it and removing it from the machine. Unless the competing automatic machine is so highly developed that it will feed itself from castings thrown into a hopper, the saving in wages is more than eaten up by the interest and depreciation on the larger investment, and by the cost of the tool-maker's attention. The hand-operated lathe is a simple machine costing only $300 or $400 with a full equipment of tools. The automatic machine for doing the same work would cost, perhaps, five or six times as much, and the tool-maker's annual charge against it is likely to be heavy.

In another line—the manufacture of twist drills—we find automatic machinery used to a very small extent. In the making of small twist drills there is a large amount of hand work. Twist drills are fluted, relieved, hardened, tempered, straightened, polished and pointed by hand. No automatic machinery has been devised, so far as we know, that does not cost more for attendance and repairs than the present human and simple machinery equipment. The difficulty seems to lie in the necessity of many handlings of pieces by operators who must feed the machines. Automatic machines there are that display almost human dexterity in handling and selective qualities, but they are costly and complicated in construction and very likely to fail in operation. There is little or no profit in an automatic machine that requires an attendant constantly. An attendant can soon acquire the skill that will enable him to run the much simpler and cheaper hand-operated machines. The success of automatic machinery in the machine tool field is most noticeable in the case of screw machines wherein the parts are practically finished complete on the end of a bar and when once cut off require little further work, of consequence. In this way the difficulty of handling parts of irregular shape is avoided. The practicability of automatic machinery for manufacturing twist drills apparently lies in the application of the same idea, that is, avoiding the handling of parts by doing all operations, including *hardening*, *tempering* and *straightening* while yet attached to the stock bar. This perhaps means a machine of the multiple-spindle type with spindles mounted in a revolving cylinder or the equivalent. So far as we know the scheme has never been tried, but it may be found to be the most feasible way of manufacturing twist drills by automatic machinery.

In the very nature of the proposition, an automatic machine can be successful only when it requires the operator's attention a small part of the working time; by this we mean machines built automatic to save labor cost, and not those made to perform certain functions automatically because of the impossibility of doing them by hand. The conclusion then is that automatic machinery is most successful in manufacturing when it is of essentially simple construction in both the operative and feeding parts. We do not think that such will always be the condition, but it appears to be so in the present state of the art of designing and building machinery.

* * *

INTERLOCKING FORMED MILLING CUTTERS.

When concave milling cutters, provided with eccentric relief, have part of the cutting edge lines perpendicular to the axis of the cutter, it is often a perplexing problem to know whether it is best to relieve those perpendicular parts or not. If the cutting edges are not relieved at those points, it is evident that they will not cut in the ordinary meaning of the word, but will simply scrape the work on the sides. If, on the other hand, these edges are relieved, then when the formed cutter is subsequently ground in the usual manner, that is, by grinding on the face of the tooth, the outline of the teeth will be changed, the perpendicular parts of the cutting edges becoming further apart as the faces of the teeth are ground down more and more. In general, of course, cutting edges perpendicular to the axis are avoided as much as possible on eccentrically-relieved cutters, but sometimes it is necessary to have them. If the exact width of the work is not of particular importance, it may be advisable to relieve the perpendicular edges, but otherwise it should never be done. One of the common fallacies in the making of eccentrically-relieved formed cutters having perpendicular edges, and one that we, in particular, want to call attention to, is that those cutters can be interlocked in such a manner as to provide for adjustment when the faces of the teeth are ground off, even though the teeth be relieved on the perpendicular faces. When the cutter has been ground so that the distance between these perpendicular faces is enlarged, it is supposed that the interlocking faces can be ground off an amount corresponding to the increase between the perpendicular faces, and that the shape of the cutter is thus retained. A little thought, however, will convince anybody that there are very few cases of formed milling cutters where the original shape of the cutter would be retained. If the cutter be concave at the center where the two halves of the cutter are interlocked, then, if it be perfectly circular when the cutter is new, the grinding away of the faces will produce a sharp corner at the juncture, which will become more and more pronounced as the faces are ground off.

The interlocking of formed milling cutters, which are relieved on the perpendicular faces, therefore, should only be permitted when the width between these faces is the most essential dimension, and the form of the work, otherwise, can stand slight changes; but, if the work is expected to be absolutely of the same shape in all respects, perpendicular cutting edges on the formed cutters should be avoided. Whatever finish is necessary on the sides of the work should be performed in a separate operation with ordinary cutters. The belief that formed cutters, however relieved, can be ground without changing their shape, and that they can be interlocked so as to provide for any changes that would occur on account of their side relief, is so common that we consider it important to call attention to this error.

* * *

It may be that we seldom are able to achieve all that we try to achieve, but it is well to constantly have a high aim ahead of us. The man with ideals measures higher and grades better than the man without ideals and ambitions; and besides, if one measured up to one's ideals, and achieved all that one's ambition demanded, that would simply be a sign that one's ideals and ambitions were not high enough.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

It is reported by Consul-General Robert J. Wynne that the ninth tunnel under the Thames, London, will shortly be opened. Of the tunnels under the Thames, five are used exclusively by subways and railroads, and the other four used for general traffic.

Evidence of the industrial progress of Germany is given by the increase in its coal consumption which, according to the *Mechanical World*, increased nearly 40 per cent between 1902 and 1907. In 1907, the increase in the coal consumption over that of 1906 was 9 per cent.

Japan's advance in machine building is indicated by the fact that its exports during the last year were five times greater than the average for the last five years. A large proportion of the exports consists of cotton gins, textile machinery, and printing presses, for China.

It is mentioned in an item in the *Horseless Age* that the city of Milwaukee will, in a short time, use no horses for municipal purposes, except to draw fire engines. The city officials are convinced that the automobile is so far in advance of the horse in cost, maintenance, and utility, that there is hardly any room for a comparison.

Another step toward the accomplishment of aerial navigation made by Mr. Henry Farman, the winner of the Deutsch-Archdeacon prize referred to in the March issue of the engineering edition, in covering a complete circle two and a half times at Issy-les-Moulineaux, France. The total length of the flight was over a mile and a half.

A chimney, 400 feet high, is to be erected for carrying off the fumes from the assay furnaces from the new ten-story Assay office building of the United States Treasury Department in New York City. The chimney is intended to carry the poisonous fumes entirely above the surrounding high office buildings in the neighborhood.

The second largest masonry arch in the world has, according to *Engineering News*, recently been built on a new railway in Austria. This arch is the largest span of a bridge over the Isonzo River, and is 278.9 feet, having a rise of 78 feet. The arch is of cut stone founded on reinforced concrete footings, backing into solid rock. It is 6.6 feet thick at the crown. The largest masonry arch in the world is at Plauen, Germany, having a span of 295 feet, and the hitherto second largest, at Luxembourg, with a span of 277.6 feet.

England's first skyscraper will, according to the news despatches, be built in Liverpool, the city having authorized the construction of an office building which will rise to a height of 300 feet over the street level. The site of the new building is opposite the Prince's landing stage on the bank of the Mersey. It is rather surprising that conservative England is the first European country to adopt the American high building construction. On the other hand, considering the disadvantages that follow high buildings, it is not likely that continental Europe will permit itself to be deluded into allowing structures of such enormous height.

Lead, according to *Cassier's Magazine*, is said to act like steel at ordinary temperatures when reduced to a very low temperature in liquid air. It will serve as a helical spring, for example. This behavior of soft, non-elastic metals is very interesting. It shows how very important temperature is. Just as iron is soft and inelastic at a high red color, so lead is dull and soft at ordinary temperatures, for it is well on its way to be melted. Mercury is actually fluid at ordinary temperatures, but can be frozen at about 20 degrees F. into a soft metal. At lower temperatures it may, perhaps, be possible to make springs of mercury.

A correspondent to the *Times Engineering Supplement* states that a well perfected process for the construction of artificial gems has been developed by the Deutsche Edelstein Gesellschaft, at Idar, Germany. Instead of building up a stone from fragments, by which means the so-called "reconstructed rubies" are obtained, this company is said to make flawless rubies and other precious stones of perfect color and brilliance, and of great size, directly from the chemical elements. These gems possess all the chemical and physical properties of the real stones, and are indistinguishable from the genuine, even by experts. They can moreover be obtained in the most perfect tints, and of any required size.

The experimental stage of electric traction on the Swedish State Railways has now been concluded, and the Department of Railways has furnished the government with a report of all the experiments. The fact particularly accentuated is that mono-phase alternating current provides for the simplest, best, and cheapest system for electric traction on railways. The department states that, in its opinion, there is, at the present time, no reason for delaying the electrification of the main portions of the state railways. The experimental section will be left intact for carrying on experiments later on for determining some details which may be required to be investigated as the work proceeds.

An interesting phenomenon that may be of use in the ignition of explosives is creating some interest in Germany. According to a consular report, it has been discovered that an alloy of iron and cerium, lanthanium, or any other of the rare substances which are used in the manufacture of incandescent gas mantles will create luminous sparks on being struck with a metal tool, such as a knife edge, file or the like. The sparks given off at the point of impact are sufficient to ignite not only gas, but even a cotton wick saturated with alcohol, and it is possible that these alloys may be utilized for igniting all kinds of explosives. The behavior of these alloys has been found to vary according to their percentage of iron, the sparking reaching a maximum when the iron content is 30 per cent.

The substitution of a cheap and indestructible material for timber used in mines is a problem which sooner or later will come forcibly before mine owners and engineers. Experiments have been carried on in England with reinforced concrete beams, which point to the possibility of using this material largely as a substitute for wood, especially for work which is intended to be of a relatively permanent nature, and in which the increased cost of the concrete beam is justified by its indestructibility and freedom from decay. As the cost of Portland cement tends to fall, while that of timber rises, it is, says the *Times Engineering Supplement*, only a question of time when concrete will become a very effective means of construction for mining operations. In this country, at the present time, reinforced concrete beams are manufactured and sold for mining purposes in the mining districts of Colorado.

In the February and March, 1907, issues of MACHINERY the Poulsen system of wireless telegraphy was referred to. At the present time the inventor is paying more attention to the question of wireless telephony than that of telegraphy, although, of course, an advance in one direction may, in a sense, always be considered as an advance in the other. The results so far obtained by wireless telephony by the Poulsen system have been gratifying. Music has been transmitted for a distance of 290 miles, and conversation 170 miles, the reproduction of the speech being clear, and the voice easy to recognize. The question of wireless telephony is of particular importance in Europe, where many of the countries are segregated from one another by the sea, for comparatively

short distances. Telephoning through submarine cables has presented great difficulties, and for this reason it is expected that wireless telephony will fill a distinct demand.

An idea in electric heating which, however, would not be applicable to the United States, is mentioned in the *Western Electrician*. Throughout Germany and most of Continental Europe, the prevailing method of heating rooms is by means of large ornamental tile stoves, which reach nearly to the ceiling, and have a large heating surface at a rather moderate temperature. These, of course, are usually intended for wood or coal. A system of electric heating adapted to these stoves has, however, recently been brought out in Berlin. An electric radiator is mounted inside the stove, so that it will rapidly heat the walls by a circulation of the enclosed air. The heat is given off from the exterior tile surface of the stove, and is thus tempered so as to avoid the dry, high temperature effect. As the average cost of current in Germany is about 4 cents per K. W. hour, this system seems to have opened up a promising field for electric heating in that country. It is stated that an average sized room can be heated in one hour, and will then remain warm for a considerable period, as the tiles retain their heat for a long time.

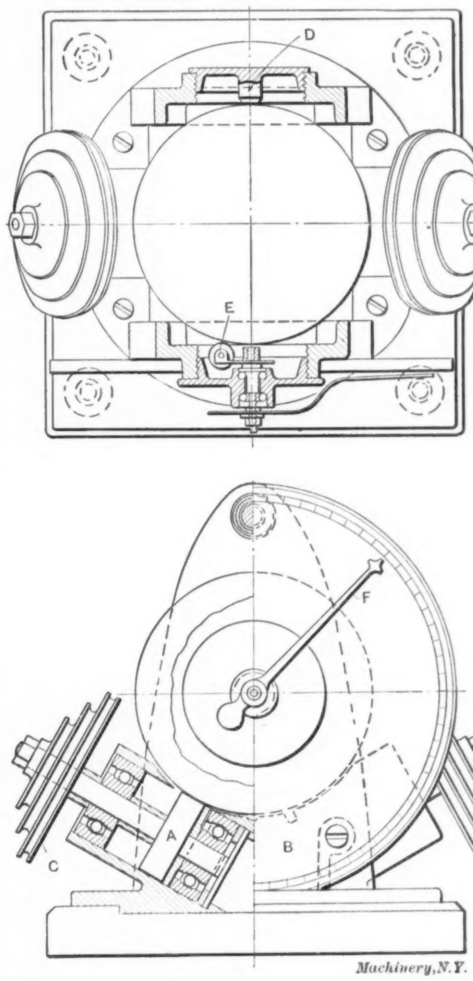
In view of the present agitation for the safeguarding of the life and limb of industrial workers, and in connection with the recent exhibit of safety appliances which took place in New York City during April and May, some figures given by Dr. Joseph A. Holmes in the Bulletin of the United States Geological Survey, although they refer in particular to the coal mining industry, should be of interest to everybody who realizes the necessity of greater vigilance in regard to safety appliances. Dr. Holmes says that the experience in deeper and more dangerous coal mines, particularly in Belgium, indicate that American mine accidents may be reduced to less than a third of their present frequency. He says that American coal mining methods are less safe than those of any other country. In 1906, 3.4 men were killed for every one thousand employed. In Belgium the corresponding figure was only 0.94 in the same year. In Great Britain the corresponding figure was 1.29, and in France 0.84 in 1905, and in Prussia 1.8 in 1904. What makes this comparison all the more significant is a further statement by Dr. Holmes that in no country in the world are the natural conditions so favorable for the safe extraction of coal as in the United States. The work done both privately and publicly for safeguarding industrial workers, both in the coal mining industry and in other fields of industrial activity, should receive increased impetus from statistics of this character.

NEW USE FOR MANGANESE STEEL.

A good example of how the development of one industry helps another is found in an order for manganese steel disks recently placed by the Cutler-Hammer Clutch Co., of Milwaukee. This company, in addition to manufacturing magnetic clutches, makes a specialty of lifting magnets for handling pig iron and scrap metal. The growth of this latter business and the natural desire of the manufacturers to perfect every detail of their product has led to the adoption of manganese steel for coil shields—the coil shields being the flat disk fastened to the under side of the lifting magnet for the double purpose of protecting the magnetizing coil and interposing between the two poles of the magnet an area of non-magnetic material. Brass, which is non-magnetic, has heretofore been used for this purpose. Ordinary steel will not do, because it is a magnetic metal and would serve to conduct the magnetic lines of force from pole to pole instead of compelling them to seek a passage through the material to be lifted. Manganese steel seems to be the ideal metal for this purpose. It is non-magnetic, like brass, and infinitely harder—so hard, in fact, that the continued hammering of the pig iron or other metal on the under surface of the magnet makes not the slightest impression on it. The 50-inch magnets recently furnished by the Cutler-Hammer Clutch Co. to a number of steel mills in the Pittsburg district are all equipped with manganese steel coil shields instead of with the brass coil shields formerly used.

DIFFERENTIAL SPEED INDICATOR.

An interesting differential speed indicator was shown at the Exhibition of the Royal Society, London, England, on May 13. The device was exhibited by Sir John Thornycroft, and the accompanying illustration is taken from *Engineering*, issue of May 15, 1908. The device consists of two cylindrical rollers, one of which is shown at *A*, and the other located at the opposite side of the device inside of the cover *B*, in a position similar to that occupied by the roller *A*, only inclined to an opposite angle. The axes of the rollers are in the same vertical plane, simply being inclined to one another, as mentioned, after the fashion of the guide rollers of a conveyor. These rollers are mounted on shafts on the ends of which are mounted pulleys *C*, which in turn are driven from the shafts the relative speeds of which are to be compared. Resting on these cylindrical rollers is a solid steel ball, 3 inches in diameter. To prevent the ball from rolling off the rollers, it is held in place at the back by a small stop *D*, and



Differential Speed Indicator.

at the front by a small wheel *E*, as shown in the plan view of the device. The wheel *E* is mounted on an arm fixed to a spindle, free to rotate, so that the wheel with its carrying arm forms a sort of caster. It is clear that if both the supporting rollers are driven at an equal speed in the same direction, the ball will rotate about a transverse horizontal axis and will carry the caster wheel either vertically up or down, as the case might be. Its direction will be indicated by the pointer *F* on the graduated scale of the device. If either of the supporting rollers runs faster than the other, the ball would rotate about some inclined axis, and the caster wheel would naturally turn so that its axis would be parallel to that of rotation of the sphere. The indications of the instrument are claimed to be very definite, and it is stated that a difference in speed of the rollers due to a nominally 2½-inch diameter driving pulley being 0.001 inch less in diameter than the other, can be detected.

While the device itself may be as sensitive as this statement indicates, it seems, however, that to make the indications absolutely sure the motion should be transmitted from

the respective driving shafts, not by belt drives, as indicated, but by some means of positive drive, like gearing, or at least by chain drive. The slip of the belt alone, it seems, could effect a change in the speeds of the two cylindrical rollers, so that the sensitiveness of the device would be largely neutralized.

RECENT DEVELOPMENT OF THE GAS TURBINE.

Alfred Barbezat in *Cassier's Magazine*, April, 1908.

In the March, 1907, issue of MACHINERY an illustrated article was published on practical results with actual operative gas turbines in France. This article consisted of an abstract from an article on the gas turbine in *Cassier's Magazine*, for January, 1907. The same magazine has again published additional information regarding the recent developments in this field, the following abstract containing the most important points regarding these developments.

The first experiments with gas turbines were made with a small turbine of the same type as the De Laval steam turbine, capable of developing about 30 H. P., and after noting the performances of this machine when driven by compressed air alone, arrangements were made to use it in connection with a combustion chamber, delivering the products of the combustion of liquid hydro-carbon fuel at constant pressure through a nozzle upon the blades of the turbine. The combustion chamber is provided with a refractory lining, and in dealing with such high temperatures of combustion as are met with in engines of this kind, the temperature of combustion being over 3,200 degrees F., the best refractory lining has been found to be carborundum, this material being a product of the electric furnace, and thus having already sustained a higher temperature than that in the turbine combustion chamber. An elastic backing of asbestos provides for the expansion of the carborundum lining. The nozzles through which the cases are discharged are also made of carborundum. In addition to the refractory lining, the combustion chamber must be provided with a water jacket in the form of a coil of pipe imbedded in the metal of the chamber walls. When the water has circulated in the jacket tube, it is sent through small holes into the combustion gases just before they enter the nozzle, and the water is there converted into steam which acts to lower the temperature of the issuing gases to a point where they will not injure the blades of the turbine.

In order to obtain the desired result of a machine involving only rotary motion, it has been found necessary that the compressed air, by which the combustion chamber is fed, should be produced, not by a reciprocating combustion compressor, but by some form of rotary motion, preferably so arranged that it can be coupled directly to the turbine itself. This means that the complete gas turbine must also include a rotary air compressor, and that such a compressor must have a high efficiency in itself, otherwise it will produce such a large proportion of negative work as to detract materially from the efficiency of the compound machine.

After several experiments, a multiple turbine compressor was decided upon, which was found to be capable of delivering one cubic meter of air per second, at a pressure of six or seven atmospheres, with an efficiency ranging between 60 and 70 per cent. A large-sized gas turbine has been built, and in this machine the compressor is found to absorb about one-half of the power developed by the turbine. The machine when running at about 4,000 R. P. M. develops about 300 H. P. over and above the negative work absorbed by the compressor. It is stated, however, that the thermal efficiency of the machine it not as yet as high as that of a reciprocating gas engine. During the past few months a practical application of the gas turbine has been made in connection with the operation of submarine torpedoes. The turbine made for this purpose developed 120 H. P. at a speed of 1,000 R. P. M. The weight of the turbine alone is about 2.86 pounds per H. P.

While the gas turbine is, of course, still in its experimental stage, it has made a material advance during the past year, the 300 H. P. compound compressor turbine being an accomplished fact, and a number of 120 H. P. machines of special type being actually installed for service. When this rate of progress is compared with the time required to bring the reciprocating gas engine to its present state of perfection, there appears to be a reason for encouragement and interest in this form of gas engine.

PHOSPHOR-BRONZE.

Edwin S. Sperry, in the *Brass World*.

The term phosphor-bronze is used to designate an alloy of copper, tin and phosphorus, or of copper, tin, lead and phosphorus. The phosphorus is added in small quantities, with the sole object of reducing the oxide of copper, which forms during the melting. Any greater amount of phosphorus than the amount required for deoxidizing the bronze is injurious. The determination of the amount necessary to reduce the oxide of copper is quite difficult, as no two melts of copper oxidize the same. One melt may be heated longer than another, and thus absorb more oxygen. In general, however, it may be said that 0.05 per cent of phosphorus is sufficient. In making castings where scrap is used, it is often advisable to add more than enough to deoxidize the copper. From 0.10 to 0.25 per cent of phosphorus is advisable for this class of work.

Phosphor-bronze may be made in two ways: First, by introducing the phosphorus into a mixture of copper and tin; second, by first introducing the phosphorus into molten tin and making a phosphor-tin. This, in turn, is then added to the copper. The introduction of phosphorus into copper and tin while melted, as in the first process, is a dangerous operation, and accompanied by a loss of phosphorus. Sticks of phosphorus, kept under water to prevent spontaneous ignition, are placed in a bell-shaped arrangement of graphite called a phosphorizer, and the whole is pushed down under the surface of the molten copper. A violent ebullition takes place, with much loss of phosphorus, and danger to the operator. From 20 to 30 per cent of the phosphorus burns, the rest alloying with the copper.

The second process, in which the phosphorus is introduced into the molten tin, to make phosphor-tin, embodies the same processes as those outlined above, except that the phosphorus is first introduced into tin alone. As tin melts at a much lower temperature than copper, the introduction of phosphorus is attended with less danger. The copper is then melted in the usual manner, and the tin, and lastly the phosphor-tin, added.

One of the principal uses of phosphor-bronze is in the form of springs. A good mixture for phosphor-bronze springs is as follows:

Copper	95 parts by weight
Tin	4½ parts
5 per cent phosphor-tin....	½ part

For phosphor-bronze of the highest possible strength, the following mixture is recommended:

Copper	90 parts
Tin	9 parts
5 per cent phosphor-tin................	1 part

The mixture made according to this formula is poured into ingots, and then remelted and poured into sand castings. The remelting increases the strength. For ordinary work, when a medium strength is required, and when scrap must be used over and over again, the following mixture is recommended:

Copper	90 parts
Tin	8 parts
5 per cent phosphor-tin................	2 parts

The scrap from this mixture may be used over and over again, with good results.

Phosphor-bronze, for use as bearings, which is one of the principal uses of phosphor-bronze in machine tool construction, must always contain lead. It is the lead which gives the bearing its "anti-frictional" qualities. The phosphorus prevents the separation of the lead. Lead may be present in the mixture up to 15 per cent, but the majority of makers use less. Tin must be used in the mixture as well. A good, general mixture of phosphor-bronze bearings is as follows:

Copper	80 parts
Tin	8 parts
Lead	10 parts
5 per cent phosphor-tin................	2 parts

Zinc should never be present in phosphor-bronze. It causes liquidation and formation of tin-spots in a marked degree.

Tin-spots are small, hard, white masses in the interior of the casting. Frequently they are so hard that a file will not touch them. The excess of phosphorus in phosphor-bronze mixtures is also a cause of tin-spots. The secret of success in producing phosphor-bronze, in fact, is simply, in the first place, to keep the phosphor content down as low as possible in consistency with the serving of its purpose, and not to add any zinc.

NEW DEVICE FOR VARIABLE SPEED TRANSMISSION.

Abstract from pamphlet entitled *Theory and Practice of the Dieterich Universal Drive Axle.*

An interesting variable speed device has been brought out and patented by Mr. L. M. Dieterich, president of the Herma Securities Co., Kansas City, Mo. The fundamental principle of the device is best understood by reference to the diagrammatical view in Fig. 1. In this, *A* represents the shaft driven at the variable speed, while *B* and *C* are two disks receiving their motion in some suitable manner from the driving source, and running loose on the shaft *A*. The disk *D* is pivoted on the arm *B* at *O*, so that it can be inclined as shown by the dotted lines. The arm *B* is keyed to the shaft *A*. The drive to the shaft *A* is transmitted through this arm *B* from disk *D*, provided that this disk with its pivot *O* is given a rotary motion around the axis of shaft *A*.

It will be noticed that the inside of disks *B* and *C* are of spherical shape, so that when disk *D* is inclined, it will still be in contact with both of these outside disks. Now, if disk *D* is parallel to shaft *A*, and the two disks *B* and *C* are revolving in an opposite direction at the same speed, it is clear that while the rim of disk *D* will be revolving about its pivot *O* and around an axis at right angles to the axis of shaft *A*, the center of disk *D* will be stationary in relation to the axis of shaft *A*. Consequently, the arm *B* and the shaft *A* will also remain stationary. If, however, the disk *D* is placed in an angular position as indicated by the dotted line *EF*, it will be in contact with the disk *B* at the point *E* and with the disk *C* at the point *F*. The point *E* on disk *B* is revolving at a higher circumferential speed than the point *F* on disk *C*, the former point being located on a larger circle than the other. Under these conditions, it being assumed that there is no slip between the disk *D* and the driving disks *B* and *C*, the center *O*, where the disk *D* is pivoted, must assume a rotary motion around the axis of shaft *A*, and the shaft *A* will consequently be carried around or driven at the speed determined by the angularity of the inclination of the disk *D*. The greater the angularity, the greater will be the difference in the driving diameters of the two disks *B* and *C*, and the greater also the speed of shaft *A*. It will be seen that it is possible to revolve the shaft *A* to any speed desired from zero to maximum, by giving the disk *D* different angular positions. It is also evident that by inclining the disk *D* to a position opposite to that of the line *EF*, as shown by the other dotted line in Fig. 1, the shaft *A* can be revolved in a reverse direction, although the two driving disks revolve constantly at the same speed, but, of course, in opposite directions.

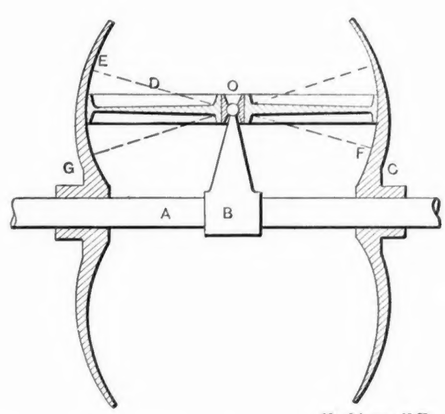


Fig. 1. Diagrammatical View illustrating Principle of Variable Speed Device.

This principle has been made use of in constructing the variable speed device shown in Fig. 2. A bevel gear *H*, mounted on the end of the driving shaft, gives motion to two bevel gears mounted on bearings concentric with the shaft *A*, which is the shaft to which motion is to be transmitted. These two bevel gears are provided with spherical surfaces on the inside, which form a contact path for the cork surface of the disk *D*. This disk revolves on an annular ball bearing, the inner surface of which is placed on a ring, pivoted on a stud in the head-bearing of an arm, keyed to the hollow shaft. As will be seen, the principle of the drive has been transferred almost identically to the practical working apparatus.

A lever, integral with the pivoted ring is operated by a linkage system, consisting of a stud reaching through a slot of the axle wall to a rod, the outer end of which is similarly connected with a sleeve revolving with the axle. An annular groove of this ring forms the path of the studs inserted into a forked lever, which, being pivoted in the axle housing, permits, by its operation, the oscillation of the floating disk. This device shows the simplest design of the principle explained, applied to a variable speed mechanism intended for automobile work. Or course, the principle can be applied to more complicated devices, fulfilling their object in even a more perfect way than the one shown, and the inventor has brought out several different models.

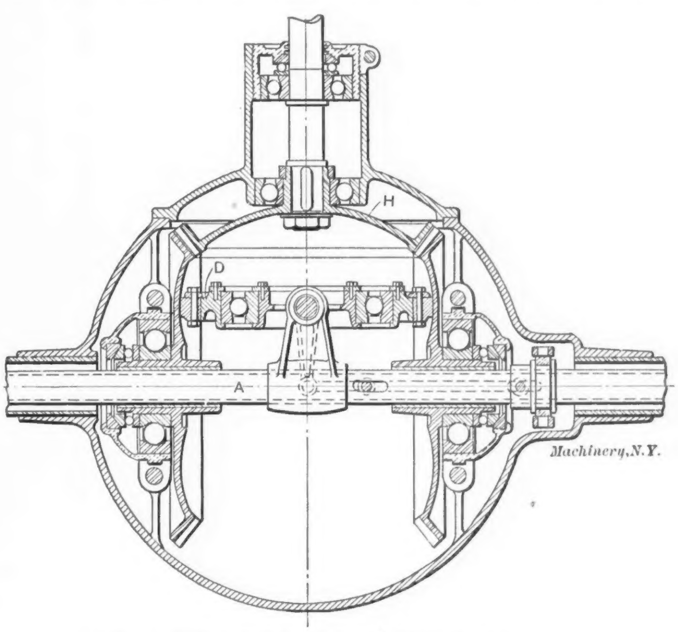


Fig. 2. Sectional View of the Variable Speed Device.

[The one objection to drives based on this principle is that the variation of speed does not change the torque, so that even though the speed be small, the torque will not be proportionally greater, on account of the fact that the limiting factor for the torque is the frictional adherence between the driven and driving contact surfaces, and this frictional resistance is independent of the speed at which the shaft *A* is running. Consequently, while variable speed devices in general are of such construction that the torque increases when the speed decreases, in the present case the speed is variable, while the torque remains constant. As the main feature of variable speed devices is often not the variation of speed in itself as much as the increased torque obtained by a decrease in speed, the objection referred to is one of great importance.—EDITOR.

* * *

The Cunard steamer *Lusitania* established a new record for a day's run June 9, when she reeled off 641 knots in 24 hours. Until the advent of the *Lusitania*, the record was held by the *Deutschland*, of the Hamburg-American line for her performance of 603 knots, July 29, 1901.

* * *

Felice Nazarro, an Italian automobile driving expert, made a world's record June 8. He drove a car on the Brooklands track, London, 2¾ miles at the rate of 120 miles per hour. This record does not include the swiftest mile, however. Demogeot, driving a car on Ormond beach, January, 1906, covered two miles in 58 4/5 seconds, or at the rate of 122.4 miles per hour. The best mile straightaway is held by Marriott, driving a Stanley steam car one mile in 28 1/5 seconds.

MAXIMUM STRESSES—3.*

JOHN S. MYERS.†

COMBINED TORSION AND BENDING.

One of the most familiar examples of combined stresses is that of torsion and bending, the torsional stresses being shearing stresses, and the bending stresses being tension and compression stresses. The maximum stress may be found by first calculating each separately, and then combining them according to formulas 26 and 27 as given in the May issue. A more direct method is to combine these equations with those for torsion and bending, thus producing formulas which give maximum stresses at once.

Let M_b = bending moment,
M_t = torsional moment,
I_r = rectangular moment of inertia,
I_p = polar moment of inertia,
Z_p = polar section modulus,
C_r = distance to extreme fiber from rectangular axis,
C_p = distance to extreme fiber from polar axis,
S = unit shearing stress due to torsion,

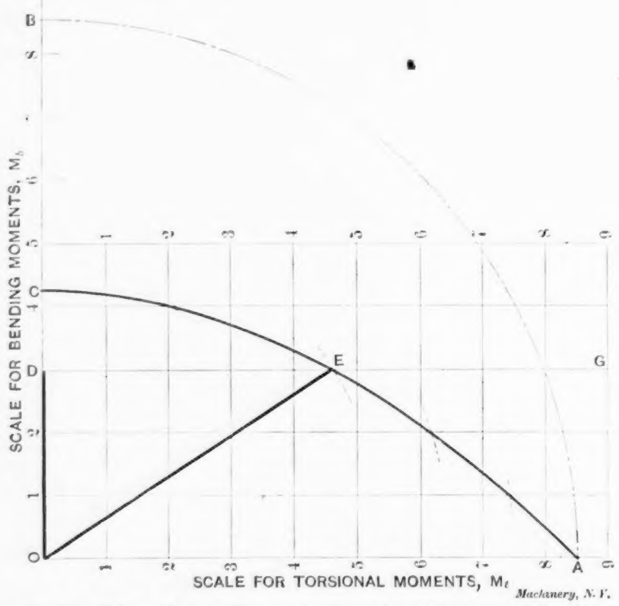


Fig. 8. Method of plotting Curves for Combined Torsion and Bending.

t = unit tensile or compressive stress due to bending,
S_m = maximum or combined shearing stress,
t_m = maximum or combined tensile or compressive stress.

Then

$$S = \frac{M_t C_p}{I_p} \quad (31) \qquad t = \frac{M_b C_r}{I_r} \quad (32)$$

$$S_m = \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \quad (26) \qquad t_m = \frac{t}{2} + \sqrt{S^2 + \left(\frac{t}{2}\right)^2} \quad (27)$$

Substituting the values of S and t as given by formulas (31) and (32) in equations (26) and (27), gives,

$$S_m = \sqrt{\left(\frac{M_t C_p}{I_p}\right)^2 + \left(\frac{M_b C_r}{2 I_r}\right)^2} \quad (33)$$

$$t_m = \frac{M_b C_r}{2 I_r} + \sqrt{\left(\frac{M_t C_p}{I_p}\right)^2 + \left(\frac{M_b C_r}{2 I_r}\right)^2} \quad (34)$$

Formulas (33) and (34) are general, being applicable to any case of combined torsion and bending. The most usual cases, however, are either round or square sections for which $C_p = C_r$ and $2 I_r = I_p$. Substituting these values in equations (33) and (34) gives, for round and square sections,

$$S_m = \frac{C_p}{I_p} \sqrt{M_t^2 + M_b^2} \quad (33a)$$

$$t_m = \frac{C_p}{I_p} (M_b + \sqrt{M_t^2 + M_b^2}) \quad (34a)$$

The polar section modulus $Z_p = \frac{I_p}{C_p}$; then,

$$S_m = \frac{\sqrt{M_t^2 + M_b^2}}{Z_p} \quad (33b)$$

$$t_m = \frac{M_b + \sqrt{M_t^2 + M_b^2}}{Z_p} \quad (34b)$$

Now from equation (33b) we have the quantity $\sqrt{M_t^2 + M_b^2}$ which expresses the measure of the two moments to produce torsional or shearing stresses. This quantity may be called the ideal torsional moment. Equation (34b) gives the quantity $M_b + \sqrt{M_t^2 + M_b^2}$ as the measure of the two moments to produce bending stresses, *i. e.*, tension and compression stresses. This quantity is generally termed the ideal bending moment, although this name is rather misleading, inasmuch as it is developed in connection with the polar section modulus, which is used for torsional or shearing stresses. The ideal bending moment if used in connection with the rectangular section modulus should be taken as $\frac{1}{2}(M_b + \sqrt{M_t^2 + M_b^2})$, which could more logically be called an ideal bending moment. For

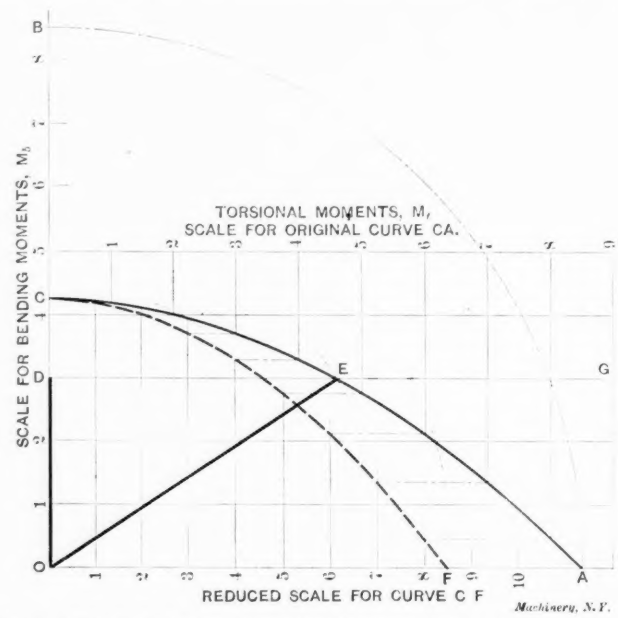


Fig. 9. Method of plotting Curves for Diagrams Figs. 10, 11, 12, and 13.

the present article, it was deemed advisable to have both expressions developed for the polar section modulus, in order that they may show the relative values of the maximum combined shearing stress as compared with the maximum combined tension or compression stresses.

Tables IX and X of the Supplement give tabulated values of the ideal torsional moment T, and the ideal bending moment B, according to the formulas

$$T = \sqrt{M_t^2 + M_b^2} \quad (35)$$

$$B = M_b + \sqrt{M_t^2 + M_b^2} \quad (36)$$

both being for use with the polar section modulus as before mentioned.

Equations (33b) and (34b) may now be written,

$$S_m = \frac{T}{Z_p} \quad (33c), \quad \text{and} \quad t_m = \frac{B}{Z_p} \quad (34c)$$

It will be noted that B is always greater than T. It is then the combined tension and compression which determines the size of section to be used, and the ideal torsional moment may be neglected entirely.

Authorities do not all agree on the subject of combined torsion and bending. The above formulas agree with Rankine's, while Grashof gives as the ideal bending moment $B = \frac{3}{8} M_b + \frac{5}{8}\sqrt{M_b^2 + M_t^2}$, or, if expressed for use with the polar section modulus as is formula (36), it becomes $B = \frac{3}{4} M_b + \frac{5}{4}\sqrt{M_b^2 + M_t^2}$. An inspection of the two formulas will show that Grashof gives greater value to the torsional moment than does Rankine, for if the bending moment be zero, then $B = \frac{5}{4} M_t$, which would agree with the usual assumption

* Continued from the May issue.

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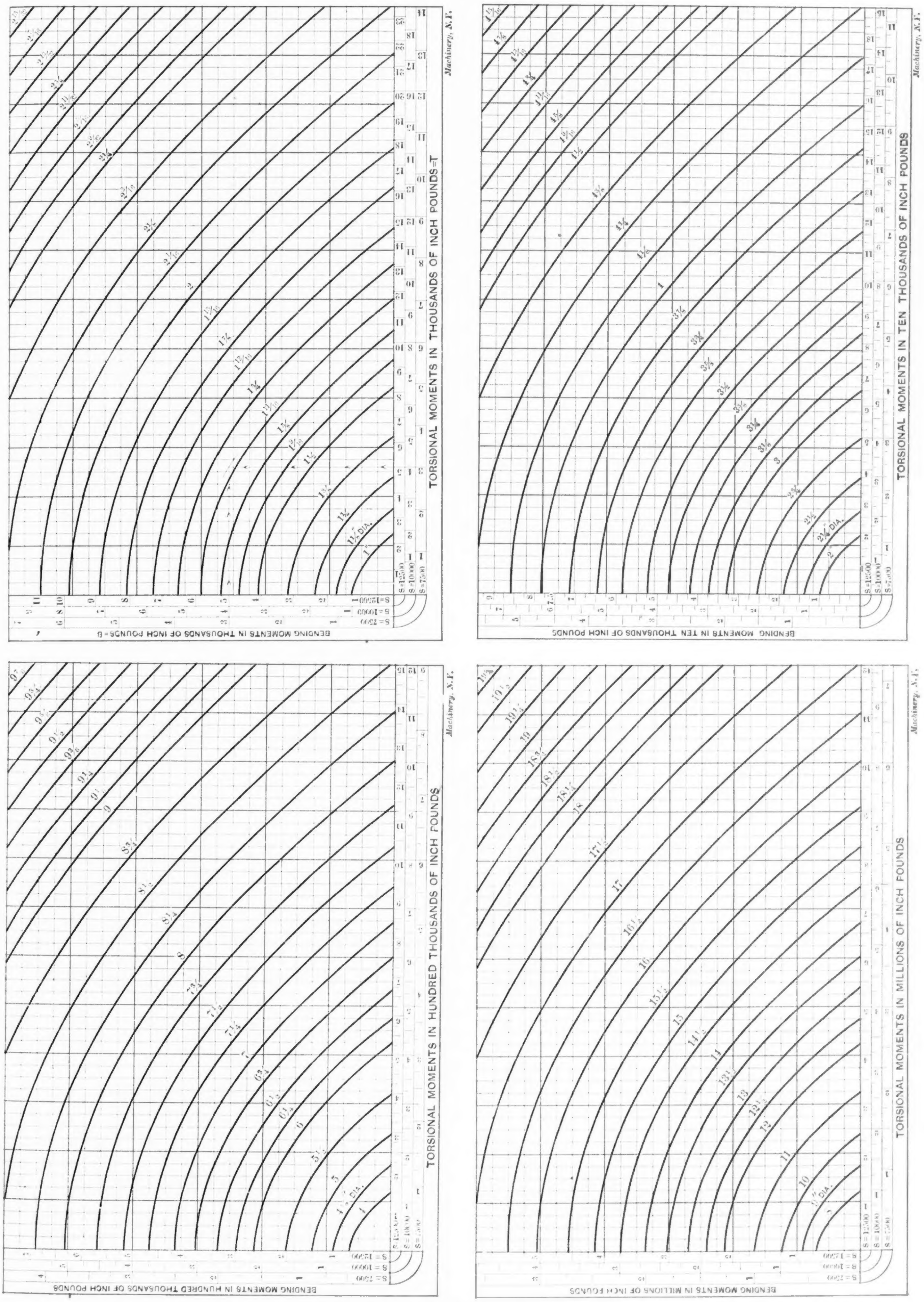

Figs. 10, 11, 12, and 13. Diagrams giving Diameters of Shafts for Combined Torsion and Bending Stresses in Thousands, Ten Thousands, Hundred Thousands and Millions of Inch-pounds.

that the ultimate shearing strength of steel is about 4/5 of the ultimate tensile stress.

In this connection it is well to note that, in the case of shafting, the location and direction of the tooth loads or belt pulls, producing bending, remain fixed while the shaft rotates. The bending stresses are thus constantly varying in direction, and since a greater factor of safety should be used for reversible stresses than for those constant in direction, some

designers recommend that the allowable working stress vary, higher stresses being used when the torsional moment predominates than are allowed when the bending moment is the greater. One of the exponents of this idea assumes an ultimate tensile stress of 62,500 pounds per square inch, and gives as the safe value of the working stress $t_m = 11{,}350$ when $\frac{M_b}{M_t} = \frac{1}{4}$, or less, and $t_m = 8{,}750$ when $\frac{M_b}{M_t} = 2$ or more, t_m to be proportional for intermediate values of $\frac{M_b}{M_t}$.

On the other hand, the ultimate tensile stress is approximately 25 per cent greater than the ultimate shearing stress; the determining stress is always the combined tension or compression, and not the shear, and since the Rankine formula is less liberal in its recognizance of the torsional moment than is that of Grashof, the writer believes the use of the Rankine formula, with a constant allowable safe stress, makes ample provision for the fact that the bending stresses are reversible.

Example.—A shaft $3\frac{1}{2}$ inches in diameter is subjected to a torsional moment of 36,000 inch-pounds, and a bending moment of 35,000 inch-pounds. What is the combined shearing stress and the combined tension compression stress?

Solution.—Referring to table X (see Supplement of current issue), and remembering that all values may be multiplied by 10 we have for $M_t = 36{,}000$ and $M_b = 35{,}000$, $T = 50{,}210$ and $B = 85\,210$. From table VII of the Supplement to the May issue for a $3\frac{1}{2}$-inch shaft $Z = 4.209$. The polar section modulus being twice this, we have $Z_p = 2 \times 4.209 = 8.418$.

By formulas (33c) and (34c)

$$S_m = \frac{T}{Z_p} = \frac{50{,}210}{8.418} = 5970, \text{ and}$$

$$t_m = \frac{B}{Z_p} = \frac{85{,}210}{8.418} = 10{,}130, \text{ approximately,}$$

A formula for computing the diameter of a shaft for combined torsion and bending may be derived from equation (34c) by substituting for Z_p its value $\frac{\pi D^3}{16}$, and for B its value as given by formula (36), and then solving for the diameter D, which results in the expression

$$D = 1.72 \sqrt[3]{\frac{M_b + \sqrt{M_t^2 + M_b^2}}{t_m}} \qquad (37)$$

Tables XI and XII of the Supplement give diameters of shaft for combined torsion and bending according to formula (37), the tables being arranged for fiber stresses of 7,500, 10,000, and 12,500 pounds per square inch to suit different classes of work or grades of material at the discretion of the designer.

Example.—At 10,000 pounds per square inch fiber stress, what should the diameter of a shaft be to sustain a bending moment of 80,000 inch-pounds, and a torsional moment of 100,000 inch-pounds?

Solution.—Referring to table XI, opposite 80 in the 10,000 pounds stress column, and vertically under 100 in the same stress column, the required diameter is seen to be $4\frac{3}{4}$ inches. The above problem, if solved by the application of formula (37) would be,

$$D = 1.72 \times \sqrt[3]{\frac{80{,}000 + \sqrt{100{,}000^2 + 80{,}000^2}}{10{,}000}} = 4.735 \text{ inches,}$$

which shows the labor saved by a convenient table. One trouble with tables is the interpretation for intermediate values. A diagram or chart is much better in this respect, and if drawn to a convenient scale should be preferable. In Fig. 8 is illustrated a graphical method of plotting a curve which will represent all the various combinations of torsional and bending moments that a shaft of given diameter and given fiber stress can withstand. The method is as follows:

Let D = diameter of a shaft, and t_m = fiber stress. Then the torsional moment the shaft can withstand $= t_m \frac{\pi D^3}{16}$. Calculate this value for any particular size of shaft and lay it off on the scale of torsional moments, as OA in Fig. 8. The location of the point A on the scale then represents the torsional moment the shaft can sustain. The bending moment the shaft can withstand is $t_m \frac{\pi D^3}{32}$, or one-half the torsional moment. Consequently, to find a point C on the scale of bending moments, which by its location will represent the bending moment the shaft can withstand, take O as a center and, with a radius equal to OA, describe an arc AB, intersecting the scale of bending moments at B. Bisect the line OB, thus locating the point C. The points A and C are now the two limits of the desired curve. To locate any intermediate point, as E, where the curve cuts any line, as DG, take a radius equal to DB, and with O as a center describe an arc, cutting the line DG at E. To show that E is a point in a curve which satisfies the conditions of the problem, equate the torsional resisting moment with the ideal moment as given by formula (36), which results in the expression,

$$t_m \frac{\pi D^3}{16} = M_b + \sqrt{M_b^2 + M_t^2} \qquad (38)$$

Now, in the location of this point, $OD = M_b$, and $DE = M_t$, then $OE = \sqrt{M_b^2 + M_t^2}$, and $OD + OE = M_b + \sqrt{M_b^2 + M_t^2}$. By construction, $OA = OB = t_m \frac{\pi D^3}{16}$; also, by construction, $OE = DB$; then $OD + OE = OD + DB = OB = t_m \frac{\pi L^3}{16} = M_b + \sqrt{M_b^2 + M_t^2}$, or location of point E satisfies equation (38), which shows the method of construction to be correct.

Having the method of locating points on the curve, we have only to locate a number of such points and then draw the curve. A diagram constructed in this manner will, however, make the length of sheet double its width, which is not a desirable proportion. To overcome this difficulty, the curves of diagrams, Figs. 10, 11, 12, and 13, were first plotted as illustrated by Fig 8. Then a new scale for torsional moments was constructed three-fourths the length of the original one, as illustrated by Fig. 9. Points where the curve intersected an ordinate on the original scale were then projected onto the equivalent ordinate of the new scale, resulting in the curve as shown by the dotted line CF.

* * *

A very satisfactory steam-pipe covering consists of a wrapping of asbestos, followed by a layer of excelsior and, over all, a piece of canvas fastened down with wire. The canvas may be painted to insure greater longevity.—*Valve World.*

* * *

On a trip made the latter part of May, the *Mauretania* had the misfortune to break one of her propeller blades. Upon her return to Liverpool the propeller was stripped, but lack of time prevented replacing it, and she made another crossing with three propellers. The absence of the propeller seemed, if anything, an advantage, and according to veracious (?) newspaper report, it is proposed to use only three propellers hereafter, instead of four.

* * *

Casein cement consists of casein and tannate of lime. A solution of tannin is first prepared, either by dissolving tannin in water or boiling Chinese gall-nuts in water and straining the fluid. Clear lime is gradually added to this solution till precipitation ceases and red litmus paper, dipped in the fluid, is colored blue. The fluid is then decanted and the precipitate dried. The dried product designated chemically tannate of lime, is then mixed with casein and the mixture ground and sifted. The proportion in which the ingredients are mixed depends upon the purpose to which the mixture is to be applied; as a rule, 90 parts of casein and 10 of tannate of lime are taken. When required for use, a sufficient quantity of water is added to the cement. A tenacious binding material of the requisite consistency is thus obtained. When completely dry the cement is very hard and tough, and absolutely insoluble in water, petroleum, or oil; consequently it is admirably adapted for a large variety of purposes.—*Scientific American.*

EVENING SCHOOL OF TRADES—RINDGE MANUAL TRAINING SCHOOL, CAMBRIDGE, MASS.

E. R. MARKHAM.*

When one has been engaged for some time in a certain work, and has seen many cases where those with whom he has associated in the work have been directly benefited, he naturally becomes very much interested therein. Eight years ago, while superintendent of a shop building machinery, I was asked to take charge of the machine shop in an evening school. I accepted the charge, and have been identified with such work ever since. Our school—The Rindge Manual Training School, Cambridge, Mass.—is open three evenings a week for 21 weeks each year to men who are anxious to learn certain branches of shop work which their experience has not given them an opportunity to learn. In our shop building there are classes in blacksmithing, pattern-making and machine-shop work, each under the supervision of an instructor who has worked for years at the particular trade he is teaching.

to the school by those who have been with us for a year, or a number of years, and that many who had several years shop experience ask us to start them off with preliminary work, in order that they may become thoroughly familiar with the principles that underlie a successful knowledge of the business.

We have had in our evening school a number of first-class tool-makers, die-makers, and others, who ranked high in the particular branches in which they were employed. These men came to us to learn some particular thing in which they knew themselves weak. I have in mind two men who were excellent workmen, both tool-makers, who had been engaged for a number of years on punch press die work; they were anxious to learn to harden dies and punches; both men spent two terms with us, and on a number of occasions have said that the time in the school was well spent.

Scope and Nature of Instruction.

As previously stated, we intend to adapt the work to the man, and thus try to help him to improve his condition. To accomplish this, we have classes in mathematics in connection

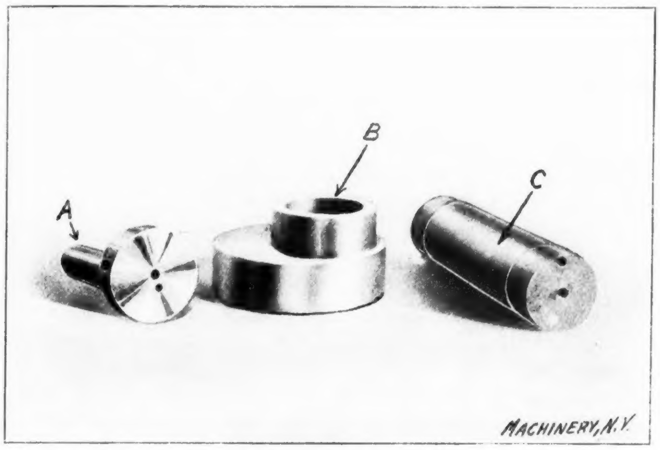

Fig. 1. Work done in Trade School—Examples of Shrink Fits and Eccentric Turning.

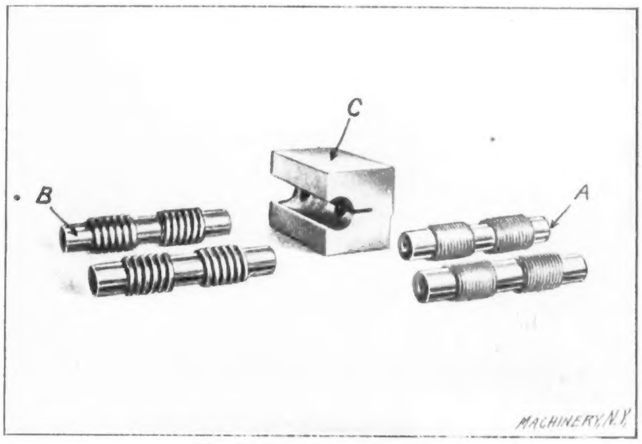

Fig. 2. First Threading Jobs.

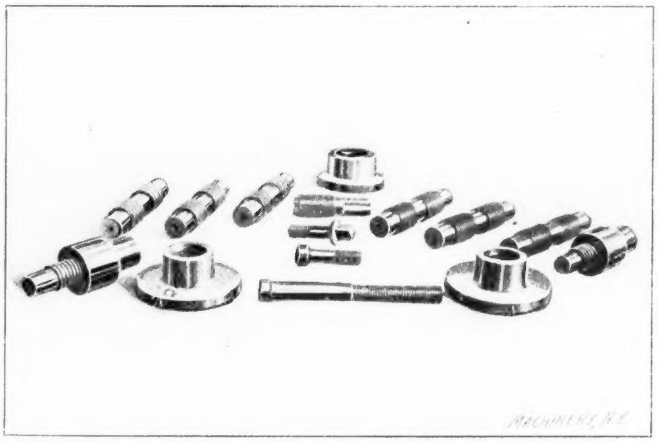

Fig. 3. Face-plates, and Additional Threading Jobs.

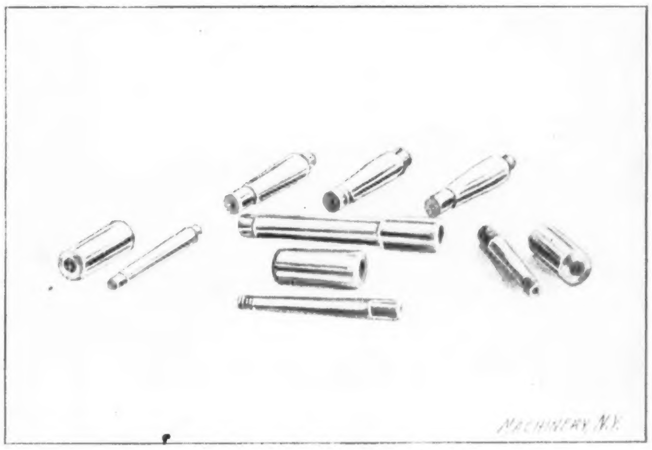

Fig. 4. Examples of Taper Turning.

As I am engaged in teaching machine-shop work, I will confine myself to the work done in that particular department. I would say, however, that the patterns for such parts of our work as are made from cast iron are made by the men in the pattern-shop, and all forgings, both of machine parts and cutting tools, are made in our forge shop.

The Purpose of the Evening Courses.

The applicants for admission to our evening courses must be engaged in the daytime in the same, or similar, lines of work. We have lathe hands who have been running lathes for years, doing straight turning, who are anxious to learn to turn tapers, to cut screw threads, or to lay off work and locate it on the face-plate of the lathe, for machining some portion or for drilling and boring. In fact, we intend making each case an individual case, and give the man just what he needs. Many times we are able to help the man in deciding just what will be for his best interest. We find, as time goes on, that new men come to us who have been induced to come

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with our shop work. In the mathematical work our men are divided into three classes, the elementary, the intermediate, and the advanced class. Each class meets one evening each week in the class room, the other two evenings are spent in the shop. The instruction given is all of a practical nature. The elementary class is composed of those men who have had very little training in arithmetic, and includes the simple principles of arithmetic, common fractions, ratio and proportion, and decimal fractions. The problems are all practical shop problems. We find the men greatly interested in the work, and they make remarkable progress.

The intermediate class, after a hasty review of the things given the elementary class, commence with ratio and proportion. They are given problems in figuring change gears of lathes for screw cutting, and similar work. Then follows mensuration of surfaces, such as finding the area of circles, rectangles, triangles, hexagons, octagons etc.; then the finding of the cubical contents of bars of various sections; then the weight of such bars, if made of wrought iron, cast iron,

steel, lead, or various alloys. This instruction is continued until the men are able to compute the weight of bars of various sizes, shapes and lengths. The student measures a bar, figures out the weight, and then weighs the bar to verify his figures. After sufficient ground has been covered, the class is given general shop problems and formulas that pertain to shop work.

The advanced class commences with weights of materials, problems in belting and gearing, and such problems and formulas as enter into ordinary shop work. The men take great interest in shop mathematics, and several have asked to be allowed to spend two evenings a week in the class room. The majority ask for extra problems to take home and work out between times. In fact, we have been very pleasantly surprised at the interest the men manifest in this branch of the work.

Instruction in Shop Work.

In the shop we have no set order of procedure. The man is given such work as seems best adapted to his particular needs. However, men who are not familiar with lathe work, or those who manifest a desire to commence at the beginning, are given the same exercise as we give the boys in our day school, as we have found by experience that greater progress is made, with a minimum waste of stock, if the elementary principles are taught by the use of exercises which involve these principles. In general, I am not an advocate of exercises, and do not use them in my day school, except to teach the elementary principles, as stated above.

The first exercise is turning a cylindrical piece of cast iron. The pupil centers it according to instructions given, squares

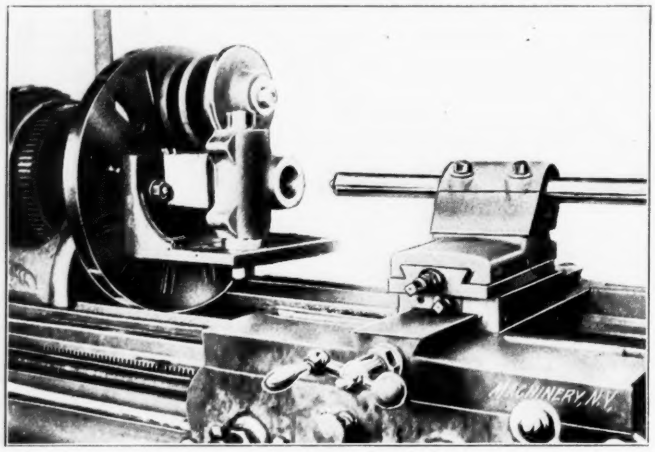


Fig. 5. Boring Job.

the ends in the usual manner, then turns it to a given size, gaging the size by means of spring calipers set to a scale. He is taught how to use the calipers to get a definite size. The lathe is then set to turn a given taper; this is done by setting over the tail-stock. No fit is attempted on this piece. The small end is turned to a specified diameter.

The second exercise is making a lathe center. The pupil is taught to compute the amount he must set over the tail-stock center to produce a taper that will fit a given lathe spindle; he measures a center that fits the spindle hole, finds how much it tapers in a given length, and then finds, by proportion, how much the tail-stock must be set over to produce the same taper on the piece he is to turn. He turns, tries, and fits it in the usual manner. When the taper is turned to a fit, and so it enters the spindle hole the proper distance, it is inserted in the hole, and the end is pointed by setting the compound rest at the proper angle, thus producing the desired angle on the point.

The third exercise is making a shrink fit. The completed piece appears as shown at *A*, Fig. 1. A disk is placed in the lathe chuck so that a center punch mark which is ⅜ inch from the true center of the disk will run true. A hole is drilled and then bored from 0.003 to 0.005 inch less than ⅞ inch, and then reamed with a ⅞-inch hand reamer. The gaging of this hole is done with a pair of inside spring calipers set to a micrometer. After reaming, the hole is measured, and the end of the cylindrical piece is turned 0.003 inch *larger* than the hole. The disk is then heated and shrunk onto it. The sides of the disk are faced parallel, and eccentric centers (⅜ inch eccentricity) are drilled in each end. The disk is then turned on the eccentric centers. We consider this a valuable exercise, as it enables us to teach several things. At first, it is not wise to try to teach more than one step at a time, and on this piece but one step is taken at a time, but successive steps bring out several different points.

After completing the shrink-fit exercise, a threading job is taken up. A cylindrical piece of cast iron is turned and threaded as shown at *A*, Fig. 2. A right-hand thread is cut at one end, and a left-hand at the other, as shown. No at-

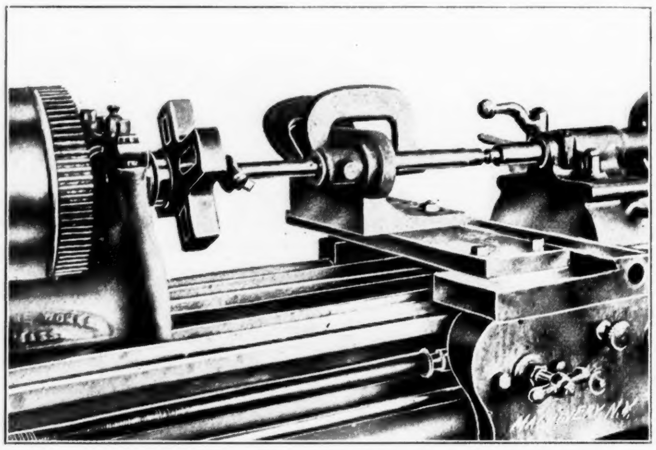


Fig. 6. Using the Boring-bar.

tempt is made to fit this to a nut, as experience has taught us that new processes are the more readily grasped when the beginner has but one thing in his mind at a time. He next cuts a right- and left-hand square thread, as shown at *B*, Fig. 2.

After these two preliminary pieces of work are completed, a face-plate is made. The face-plate is made to fit the spindle of one of the wood-turning lathes used in the pattern-shop. The hole is drilled and bored, and the thread cut with an internal threading tool until a tap of the proper size will just enter. The three end threads are recessed out. The face-plate is then taken from the chuck and the thread finished by the tap. After this operation it is placed on a threaded mandrel and turned to final dimensions. In Fig. 3 two of the face-plates are shown in the foreground, while at the back of the table is shown a chuck back. In the case of a man wanting to get an added experience in internal threading, he is allowed to make one or more chuck backs after he has completed the face-plate. Some of the men are anxious to devote considerable time to screw cutting. To these we give the job

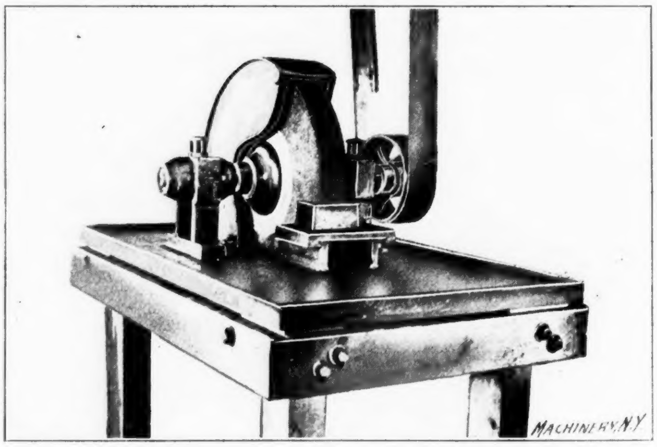


Fig. 7. Tool Grinder built in the Trade School Shops.

of making various forms of screws and threaded mandrels, as shown in Fig. 3. We are constantly reminding them of the necessity of keeping their lathe centers in proper condition, in order that the various portions of a piece shall be concentric.

Fig. 4 shows three tapered sleeves with taper holes, a drill collet, and several tapered mandrels. These mandrels have hardened ends and soft bearing portions. The ends are hardened, and the tapered portion turned afterward. After making one or more of the tapered pieces shown, the men are

given such work as will be to their advantage. We have found that it is wise for us to build machines, provided we do not "bite off more than we can chew." We do not consider it advisable to build anything that would necessitate our keeping our machines tied up for a number of weeks on one piece. It is necessary to bear in mind the fact that our men are with us but three evenings a week, and but two hours each evening.

The various parts of the different machines being built furnish a variety of work that enables us to select jobs adapted to the various men. Fig. 5 shows a job of boring, the piece being held on an angle-iron. The hole at right angles to the one being machined was bored and reamed first, the piece being held in a lathe chuck. The piece was then placed on a stud on the angle-iron as shown, and the hole bored to size.

Fig. 6 shows a boring-bar job. It was necessary to make a number of tool rests for our wood-turning lathes. The bottoms of the rests were planed. The rests were then clamped to the angle iron as shown, and the holes bored to size.

Fig. 7 shows a tool grinder built in the shop. As it was necessary to use this before the pattern for the base was completed, it was mounted on a wooden frame. We have several of these grinders under way.

Fig. 8 is a combined surface grinder and tool grinder. The knee supporting the tilting table is adjustable up and down

evening school. When getting ready to bore the hole in the head, it is, of course, necessary to locate the head on the lathe, so that the spindle holes are in exact alignment with the axis of the lathe, in order to insure the spindle standing at right angles to the table when the drill press is assembled.

While we would welcome a horizontal boring machine as a part of our equipment, I am inclined to think that the use of a machine for purposes other than it was originally designed for gives the men a certain knowledge that may be of value to them when they find themselves confronted with a special job and no machine at hand especially adapted to it. When we do a piece of work in a manner different from that ordinarily pursued in a shop, the usual method is fully explained, in order that the man may know how to go to work when the proper machine is at hand, and also how to improvise a method for doing it, if necessary. When it is necessary to have any special fixtures or cutting tools—except gear-cutters—we make them, either in the evening school or in our day school.

By the way, we read at times in our mechanical journals articles regarding manual training schools that would lead one to think that little of practical value is taught in them. I do not claim to know much about such schools in general, but I do know what our boys get. Their work is exactly parallel to that given the men in the evening school. They

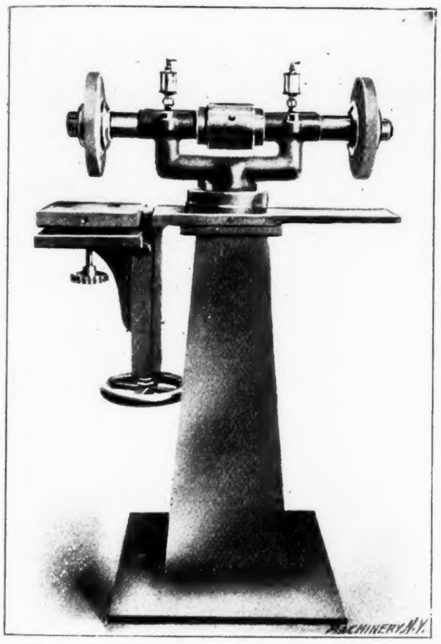


Fig. 8. Combined Surface and Tool Grinder built in the School Shops.

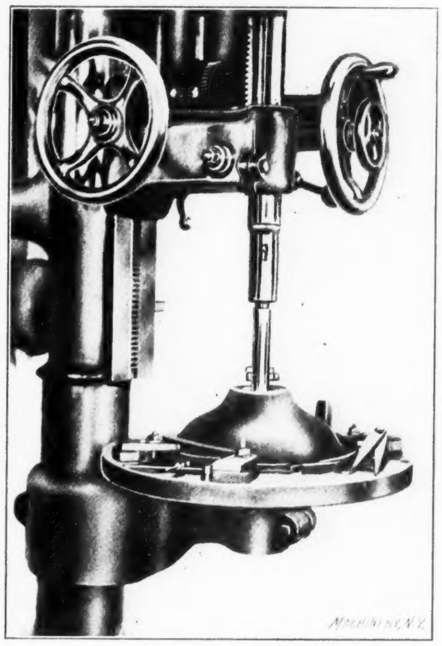


Fig. 9. Boring Small Drill Press Base.

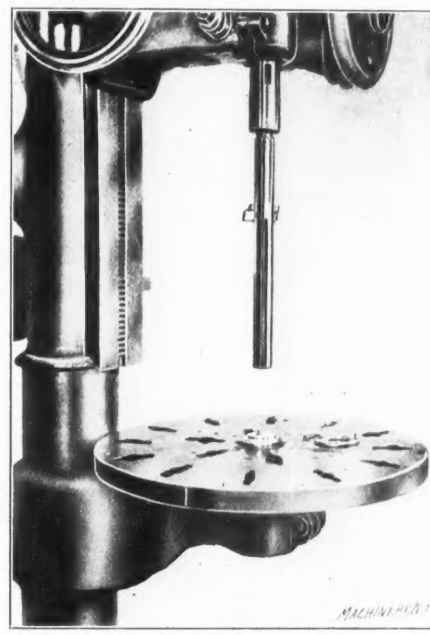


Fig. 10. Method of Guiding the Boring-bar while boring Drill Press Base.

by means of the hand-wheel shown. We have two more grinders similar to the one shown, under way. At either end of the driving pulley are hardened collars to take the end wear. One of these is threaded into the pulley, and is adjustable to compensate for wear. The grinder shown has cast iron spindle bearings, while the two being built have babbitted bearings. The babbitt is poured around a mandrel considerably smaller than the finished size of the bearings. It is then hammered and bored and reamed to size. The spindle bearings are all draw filed to fit.

We are building two small friction-driven sensitive drill presses. As we have no boring machine, we are obliged to use a lathe, or drill-press, for work that is done with a boring-bar. As we have no lathe large enough to bore the base to receive the column, we found it necessary to use the upright drill for the job, as shown in Fig. 9. In the center of the table is a bushing to receive the boring-bar. The bushing has a key which enters the keyway in the bar, shown in Fig. 10. The bushing then, of course, revolves with the bar. The table of the drill-press we make is bored to receive the column by means of a boring-bar in a lathe, as shown in Fig. 11. The table is held on an angle-iron, as shown.

The head is bored to receive the column, as shown in Fig. 12, the head being held on an improvised jig. The cutter is held in a device which screws on the nose of the spindle. Both jig and cutting tool were made by the students in the

build machines, special holding and cutting tools, repair the machines in our different shops, and, in fact, the work is as nearly parallel to actual shop work as we can make it.

Fig. 13 shows a number of the small parts of a press, other parts not being far enough along to photograph. We make it a point not to let anything go into the machines we are building that is not as nearly correct as would be found in the ordinary commercial article of the same type, but do not claim that as large a proportion of the pieces made pass inspection, as would be the case in a manufacturing establishment. Fig. 13 also shows two punch press blanking dies. The one at the left is for producing a blank, and the other receives a punch used in trimming the edge of the sheet.

Fig. 14 shows a two-jaw chuck for use on a large pattern-maker's lathe. The jaws are operated by means of the right- and left-hand screw shown. This chuck is about 15 inches in diameter.

In Fig. 1, at *B*, is shown an eccentric, and the eccentric mandrel *C* used in turning it. A large variety of eccentric work not shown in any of the photographs has been done. The individual pieces are designed to give some pupil the special training needed in his particular line of work.

At *C*, Fig. 2, is shown a fixture used in holding a sleeve that acts as a rack for moving the spindle of the drill press up and down, in the operation of drilling. The sleeve has rack teeth cut along one side to receive the small pinion shown

in Fig. 13, by means of which it is raised and lowered. The opening to receive the sleeve was drilled, bored, and reamed to size, the piece being held on an angle-iron attached to the face-plate of a lathe. It was then placed on a special mandrel, having a straight holding portion, the ends of which were of exactly the same size. These ends were supported in V-blocks on the planer, and the bottom planed with a tongue as shown. This tongue fits one of the cross slots of our milling machine tables. By the use of this fixture the rack teeth are milled at right angles to the axis of the sleeve.

In cases where special fixtures are not absolutely necessary, they are still sometimes made, and the advisability of their use is explained to the men. When it is not necessary to make them, the advantage of their use in shops where many pieces of a kind are made, is explained to them. The men attending our evening school have shown a remarkable interest in the work. The attendance has been very gratifying. Quite a number have been able to materially better themselves since attending the school; some have had an increase in pay, because they were able to do a class of work that demanded higher wages; others have obtained better positions on account of increased knowledge. A little incident, extremely gratifying to those in charge, came to our attention a little while ago. In a certain shop it was necessary to cut a fractional thread on a piece of work. The gear plate did not show gears for this thread. Several of the men were asked to "figure out" the gears; but as the lathe was of compound gear construction none of those asked were able to do it. Finally one of the men as a joke said: "Get 'Jerry' to tell you what gears are needed." "Jerry" is an apprentice in the shop, and attends our evening school. "Jerry" was consulted, and was able to tell them the proper gears to use. He says that he would not have been able to "figure the gears" but for the knowledge gained in the school.

Each man attending the evening school is given a set of notes. These notes are written or compiled by the instructor. They are then typewritten and mimeographed at the office of the "Massachusetts Commission on Industrial Education," under whose supervision the school is run. The past year has been the first that we have given the notes in the form mentioned; before this they have been given in the lectures, the men taking such notes as they saw fit. By the present system much valuable time is saved, and the men have the notes in note-book covers. Each year we propose adding to them, and think that in a few years they will make a text-book that will be of value to the men.

We do not think our course is perfect and we are constantly endeavoring to improve it; but we have the satisfaction of knowing that some of the men have been materially benefited by attending the school.

* * *

It seems that the April fool joke in the technical journal mentioned in the May issue of MACHINERY was one on the inventor of the device as well as on the readers of the paper. Instead of being the inoperative apparatus the picture and description shows, the construction is really practical and unusually ingenious. The connecting tube is made of flexible armor construction with a waterproof cover which automatically collapses under the pressure of the water until its weight per volume is equal to that of the water which it displaces. When it is collapsed to this extent, it is in equilibrium and floats in water, and it attains this equilibrium automatically. The sleeves through which the work is done are not of loose flexible material, as would be surmised from the printed description, but are of metallic construction self-sustaining because of the lateral pressure to which they are subjected. This apparatus has been built by the Williamson Submarine Mfg. & Operating Co., Newport News, Va., and used in 30 feet of water, and has been employed in actual salvage work. Of all this, however, not a word was said in the paper to which reference was made.

* * *

The battleship *Georgia* of the Atlantic battleship fleet holds the world's championship record for rapid coaling. Several days ago she took aboard 1,779 tons of coal in five hours and twelve minutes. The best former coaling record was made by the German war vessel *York*, which took on 468 tons in one hour and 870 tons in two hours.

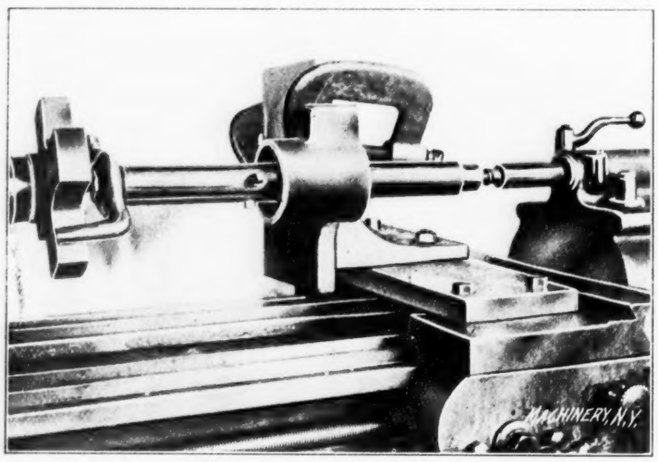


Fig. 11. Boring Column Hole in Drill Press Table.

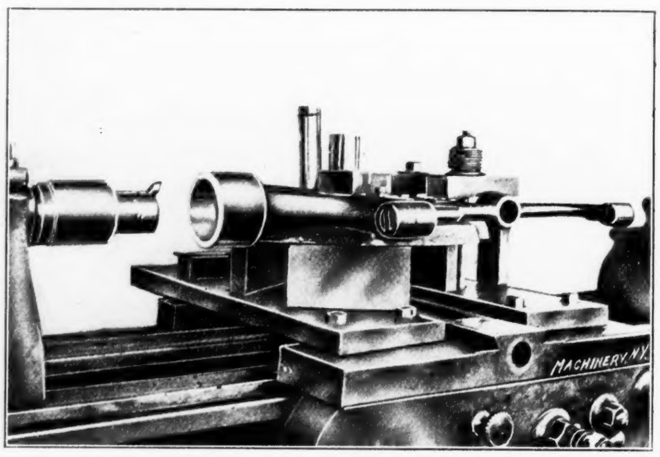


Fig. 12. Boring Hole in Head to receive Column.

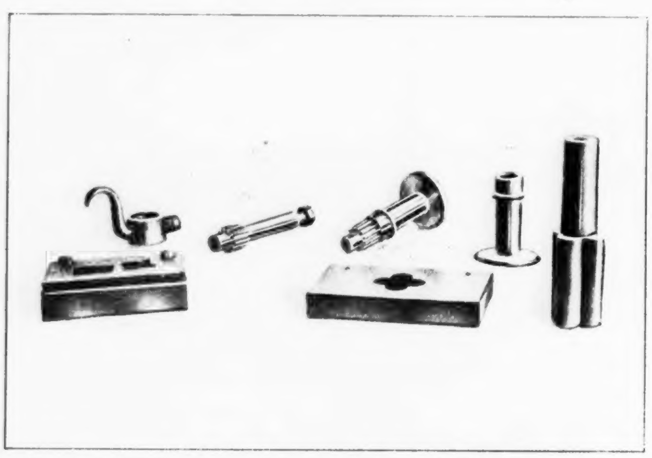


Fig. 13. Examples of Punch and Die Work, and Miscellaneous Jobs done in the Trade School.

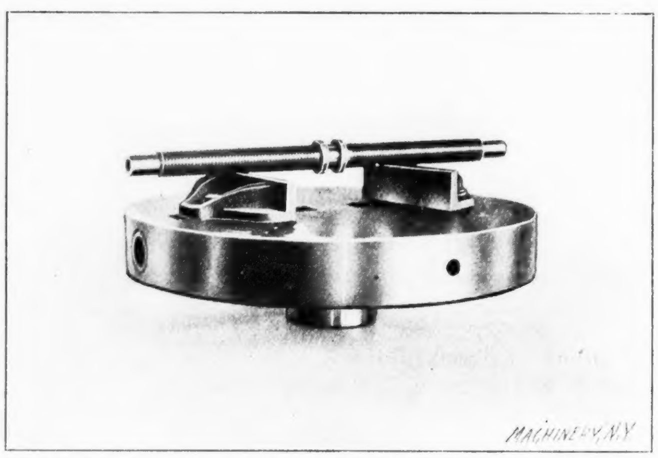


Fig. 14. A Two-jaw Chuck Completed in the Evening School.

LETTERS UPON PRACTICAL SUBJECTS.

MILLING AND DRILLING FIXTURES FOR OFFSET ROD.

In Fig. 1 is shown a slender connecting-rod which is a part of a complicated machine. One end of this rod is 3/16 inch lower than the other, and it is necessary that the 5/32-inch holes should be parallel with each other. Should either one be reamed on an angle, there being such a long distance between the holes, it would destroy the free movement which is required. Several methods were tried in drilling the holes and milling the faces of the bosses, but none gave satisfaction until the fixture and jig shown in Figs. 2 and 3 were made.

Fig. 1. Offset Connecting-rod which is milled and drilled in the Fixtures.

In Fig. 2 is shown a plan and elevation of the fixture used for milling the ends of the rod. The sides of the rod on each end are sized in one cut by a gang cutter, and the fixture is so designed that when one end of the rod is finished the other can be brought facing the cutter and yet have the required offset. The fixture consists of a cast iron body A with an attached part B which swivels about the bolt G. The lugs C on part B engage the slots D when B is turned one-half revolution, thus giving the rod, which is bolted to the hardened pieces F by the clamps E, the 3/16-inch offset. In setting the rod, it is passed under the clamps E, and against the stops F. The bearing points of both the clamps and stops are rounded off and made small, and directly opposite each other. This eliminates all possibility of the piece tipping when being clamped. As the cutter runs in the direction shown by the arrow, it has a tendency to hold the rod against the shoulders on the parts F. Consequently no heavy clamps are required. The lugs C and slots D are off center so that when the high side of the rod has been milled, the stud G is loosened and B is swung around bringing the opposite side to the cutters, and lugs C outside of the slots D, thereby raising the opposite end of the rod 3/16 of an inch and bringing it in line with the cutters. H is a locating stud which engages with the hardened bushing I, bringing B in position for the second operation. The part B with the work is held firmly by screwing up the nut J. Two small pins K prevent the clamps E from swinging around when not in use.

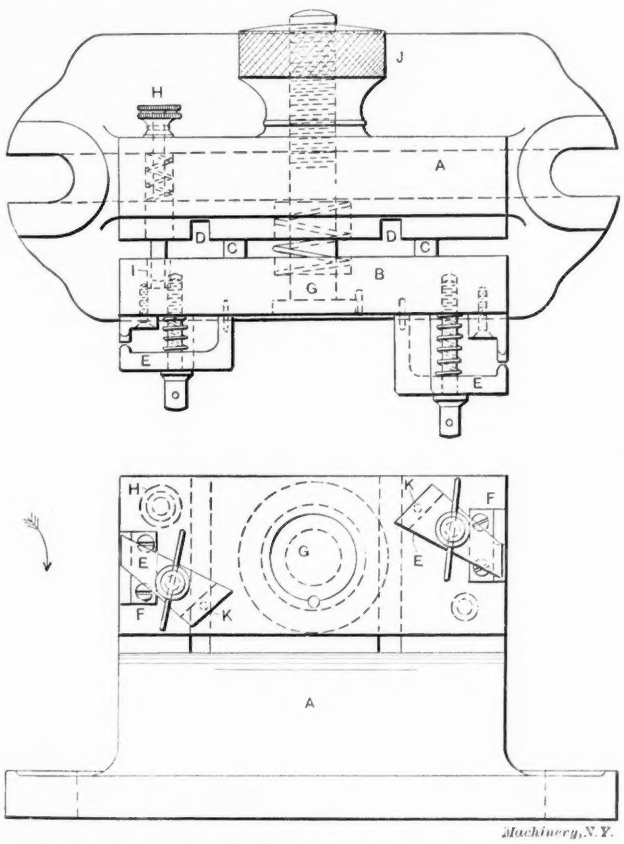


Fig. 2. Fixture for Holding the Rod while the Bosses are being milled.

The drilling jig is shown in Fig. 3. The steel body A has a V-piece at each end, and under each of these there is a hardened base, having a 3/16 inch difference in their heights. The V-piece B is screwed down solidly, while C is movable, sliding on ways. There is a small pin D extending down into the body A, against which presses a small spring. The two clamps F swing around and engage the heads of screws H. When setting the rod in the jig, preparatory to drilling, one end is placed in the V-block C which is forced back until the other end of the rod drops into place. As the block C has a pressure on it, it keeps the rod located centrally. The clamps are then swung around under the heads of screws H, and the binding screws G are brought down on the milled surfaces of the rods, holding them securely while they are being drilled. These screws have clearance holes through them, and at J are the bushings in which are placed the drill and reamer bushings.

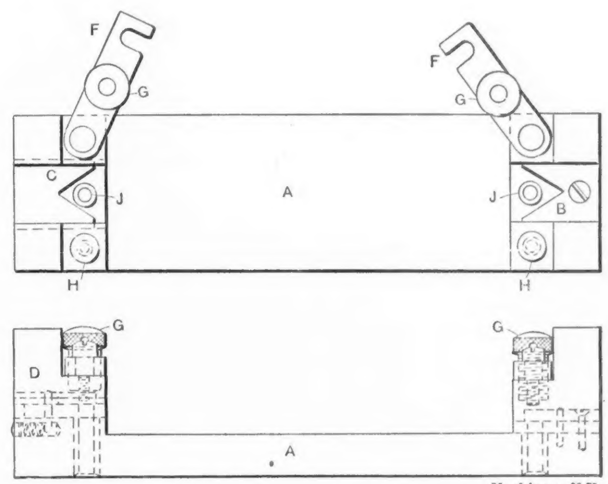


Fig. 3. Jig for Drilling the Ends of the Rod.

PEDRO.

IMPROVED DRIVING PLATE FOR THE MILLING MACHINE.

Everyone who is familiar with milling machine work knows how annoying it is to have the set-screw in the driving plate of the index head just miss the tail of the dog placed on the work, or, what is nearly as bad, strike it on the rounded part, so that when the screw is tightened it is apt to spring the arbor, if it be a light one. In our shop the work necessitates several different sizes of dogs, and in order to remedy the trouble caused by location of the set-screws, the device illustrated in the accompanying halftones, Figs. 1 and 2, was made and applied to the plate as shown. This improvement was introduced about three years ago, and has been in satisfactory use ever since.

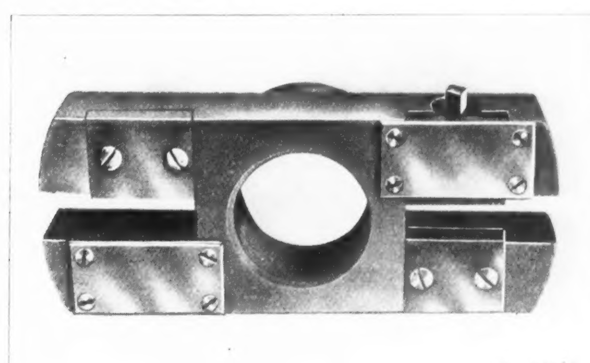


Fig. 1. Improved Form of Driving Plate for the Milling Machine.

In Fig. 1 the plate is shown exactly as it appears on the machine, while Fig. 2 shows the general construction of the device, which consists of four separate parts and six screws for each end. The stationary jaw is shown at E. This is made of hardened tool steel, and sunk into the cast iron plate, being held by two screws as shown. At F is shown an end view of the corresponding jaw which sets into the other end of the plate, and at A is shown the movable jaw, turned

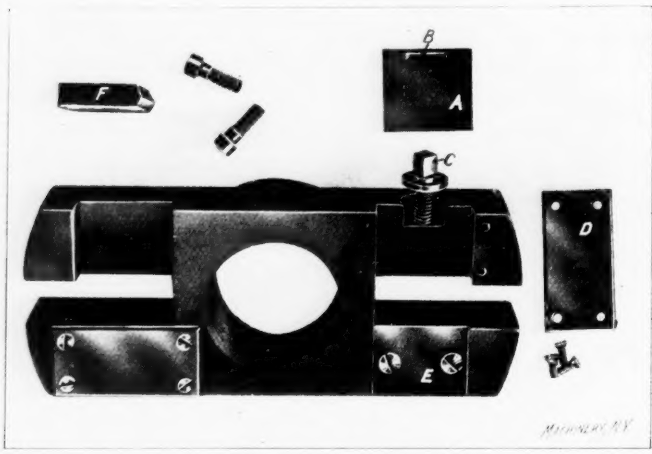


Fig. 2. Component Parts of the Driving Plate.

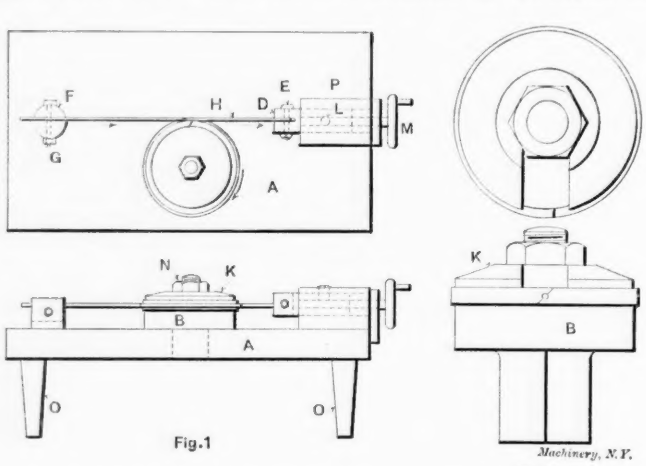
so as to show the slot B into which the shoulder of the adjusting screw C fits. The inside edges of both jaws are planed to an angle of 90 degrees, similar to the face of a chuck jaw. The movable jaw is also made of tool steel and hardened, and the screw C is made of machine steel and case-hardened. The plate D, finally, is used to hold the movable jaw in place, and is made of machine steel.

The writer has wondered why the milling machine manufacturers have not introduced something similar to this, as a driving plate constructed in this manner is far superior to one provided with set-screws. Of course, this improvement increases the cost somewhat above the ordinary driving plate, but the usefulness and convenience of the device compensate for the extra expense. ETHAN VIALL.

Decatur, Ill.

FIXTURE FOR GRINDING PISTON RINGS.

After experimenting with many different devices for holding piston rings, with unsatisfactory results, we designed the arbor and fixture shown in the engraving, the object being to eliminate egg-shaped rings. All brother craftsmen in the automobile business know that this is a mean proposition. This fixture was built with the intention of producing an



Figs. 1 and 2. Device for Closing Ring, and Arbor for Holding it when grinding.

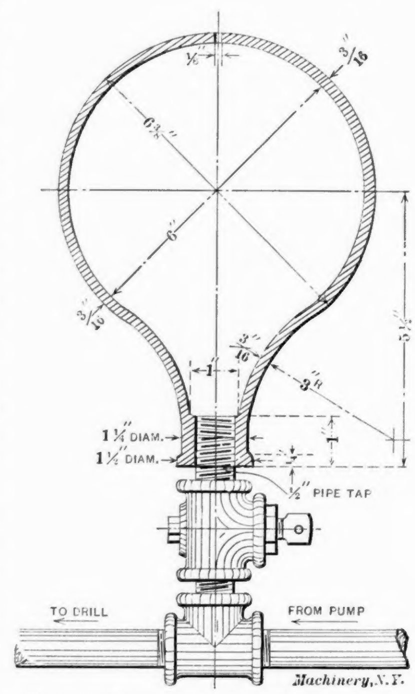
even pressure around the circumference of the ring when closing the ring together preparatory to grinding.

Fig. 1 shows a top and side view. A is a gray iron plate mounted on legs O. Upright P is bored out to receive spindle D. This, in turn, is moved in and out by screw and handle M, the same as the tail-stock spindle in a lathe. The spindle D is prevented from turning by a spline and screw L. Plate or base A has a square hole for arbor B to fit in. Stud F and end of spindle D are split to receive wire H, this being gripped tightly by drawing up bolts E and G. In operation, arbor B is placed in the square hole in A, a ring is put in place, the soft copper wire H is gripped in stud F and passed around the outside of the ring in the direction of arrows shown, and gripped again in the end of spindle D by bolt E. The wire H is tightened by the screw and handle M, thus drawing the ends of the ring together. The split collar K is put in place, then nut N is screwed against it, holding the ring firmly in a closed position. Now the wire H is released, and arbor B with ring in place is ready for the grinding operation. The face-plate of the grinder has a plate with a square hole that acts as a dog or driver for the arbor. Fig. 2 shows the arbor and work together. The body of the arbor, of course, is turned eccentric to suit the ring, and there is a mark to locate the ring in the proper position. This fixture produced rings that were round after grinding, the point being that the soft copper wire caused an even pressure all around the ring in closing it. E. W. NORTON.

North Tarrytown, N. Y.

RESERVE CHAMBER FOR PRIMING PUMPS.

The accompanying engraving shows a reserve chamber for pumping systems connected with drill presses, milling machines, automatics, etc., where individual pumps are used for oil or compounds of any kind. We found, in our drill press department, that whenever the drills stood still for a while, the pumps had to be primed before starting again, and by the way, some of the workmen were spending quite a large share of their time priming their pumps. To overcome this, we have put in use a reserve chamber which is used for priming. This chamber is placed in the pipe line between the pump and the point of discharge. The valve leading into the chamber is left open when starting the first time, and the chamber is allowed to fill up. The small hole in the top serves two purposes; it allows the air in the chamber



Reserve Chamber for Priming Pumps on Machine Tools.

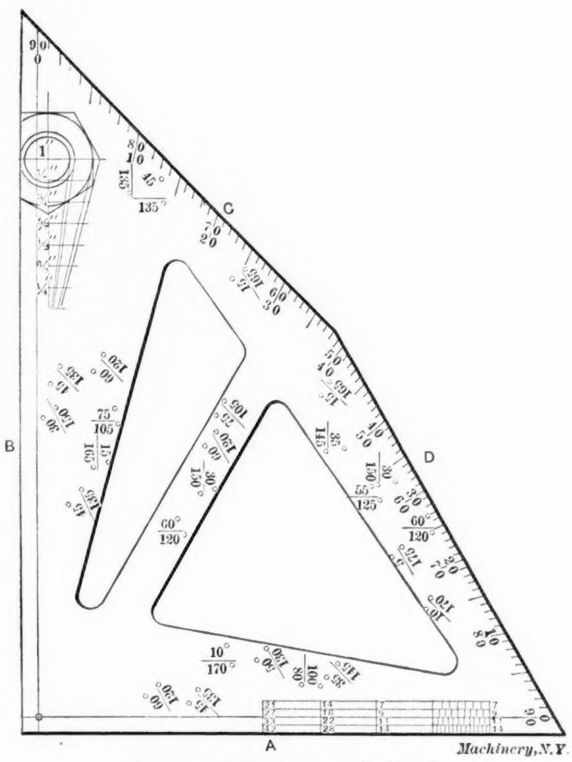
to escape when filling, and also acts as a tell-tale to indicate when the chamber is full. After filling, the valve to the chamber is closed and the chamber is kept full, the compound flowing through the pipes as usual. The pump may be left any length of time now, and started again without the trouble of priming in the old way. The next time the pump is to be started, all that is necessary is to open the valve and allow the compound to fill the pipes. This does away with priming, and is very quickly and easily done. The chamber is now allowed to fill while the driller is drilling his first few holes, the valve is again closed as before, and everything is in readiness for starting the next morning.

TOOL DESIGNER.

IMPROVED DRAFTSMAN'S TRIANGLE.

The triangle which is shown in the engraving is one which I have used for a number of years, and I think that this form is an improvement over any which I have seen. One which I made for myself was of 1/16 inch transparent celluloid, with a vertical side 12¾ inches long; of course, the size could be such as would be most convenient. It will be

noticed that this is really a 60-degree triangle with the top cut to form an angle of 45 degrees with one side, while the inside is cut out to give various angles. In the top corner a one-inch nut is laid out, and the scale gives the sizes of tapping holes, sizes across corners and flats for nuts from 1/4 to 1 inch in diameter. In the bottom corner there are scales with odd divisions not found on the ordinary scale. These could, of course, be varied, and others added if necessary. This



Draftsman's Protractor and Triangle.

triangle is also a large protractor which can be used for all angles up to 90 degrees by working from the small hole in the lower left-hand corner and the graduations along the edge. The figures shown with lines between indicate the angle of that particular edge to the T-square when that outer edge of the triangle which is parallel with the line is against the T-square. The accompanying table shows the large num-

SIDE SET AGAINST T-SQUARE.

A	B	C	D
Angles in Degrees.	Angles in Degrees.	Angles in Degrees.	Angles in Degrees.
10	15	10	5
45	30	15	15
55	35	35	30
60	45	45	45
75	80	60	50
90	90	75	60
105	100	105	120
120	135	120	130
125	145	135	135
135	150	145	150
170	165	165	165
...	...	170	175

ber of angles which can be obtained directly by placing the sides *A*, *B*, *C* and *D* against the T-square. It will be seen that there is a 45-degree side for all four positions, and a 30- and 60-degree side for two and three positions of the triangle, respectively, in addition to the various angles given in the table. R. W. DICKINSON.

Accrington, Eng.

TRICKY FOUNDRY PRACTICE.

A friend of mine having made a complete set of patterns for a bench lathe (18-inch bed, 4-inch swing) and built a first-class, serviceable machine with lead-screw and gears complete to cut any standard thread, I decided that I would like a similar machine, so I borrowed the patterns and took them to the nearest foundry and ordered a set of castings to be made. I attended to this business through the office, and was told to call for the castings in three or four days. However, as I was impatient to begin work upon the little lathe, I went around the second morning about eight o'clock and went directly into the foundry where the molders were getting ready for the day's work, and the helpers were cleaning castings. As the foreman was not on the floor at the moment, I inquired among the men until I found the molder who was working with my patterns. He informed me that they had *only got one of the lathe beds out, but had two sets of head- and tail-stocks and carriage pieces.* I asked him how many he had been told to make and he replied, "Three sets." I said I guessed one set would do me, and, gathering up the patterns, I took them out and put them in the rig I had brought, and then went back for the coreboxes, which I soon found and also deposited with the patterns. Next I hunted up the foundry foreman and got him to gather all the castings that had been made from the patterns and weigh them. He was surprised that I should order three sets and then go with only about one and a half. However, he went up to the office to get the bill while I put the castings into the rig.

I judged by the look on his face that all the surprise at my action had died away through certain things he had learned in the office, but I did not make any remarks, and paying the amount due, I drove off. The question involved is whether the proprietors of a foundry have any right to make castings for their own use from patterns brought to them by customers. Personally I think not, unless by permission. W. L. McL.

EFFICIENCY OF AUTOMOBILE TRANSMISSION.

We noticed in the June issue of MACHINERY a report of a test made by the H. H. Franklin Co., Syracuse, N. Y., in which the loss in transmission between the motor and the rear wheels is given as 6 2/3 per cent with direct drive, and 8½ per cent with intermediate gear, giving a mechanical efficiency of 93⅓ and 91½ per cent, respectively. While this test shows that the transmission of the car is very efficient, it is probable that the tire losses were not considered. If they were, the efficiency would be considerably lower.

As to the statement that the mechanical efficiency of automobiles, in general, is rated at 75 per cent, the test made on the Automobile Club of America's dynamometer shows that many cars develop much less power at the ground than their engine rating, and that, in general, the effective power at the ground is approximately 75 per cent of the nominal engine rating. This statement, however, should not be interpreted to mean that the efficiency of the transmission, including the tires was 75 per cent or less. The power developed by the engine is *not* determined in the Automobile Club of America's dynamometer tests. The fact has caused considerable misunderstanding, especially in the automobile trade, and it should be distinctly understood that the dynamometer does not show the efficiency of the automobile, but only the effective horsepower at the ground, and that the 75 per cent statement refers only to the rated engine power of cars in general.

E. H. WARING.

Ampere, N. J. Crocker-Wheeler Co.

TAPER PER FOOT OF WHITWORTH OR ENGLISH TAPER PIPE TAPS.

In Mr. Charles E. Smart's article in the June issue of MACHINERY on Whitworth or English taper pipe taps, he states that the dimensions of these taps should be based upon the standard Whitworth pipe tap gages, made in England by the Whitworth Company which have a taper of 1 inch per foot.

If Mr. Smart will refer to paragraph 7, page 6 of the "Report on British Standard Pipe Threads for Iron or Steel Pipe and Tubes," of April, 1905, issued by the Engineering Standards Committee, he will find the taper of Whitworth pipe is equal to ¾ inch per foot. Before this report was issued, it was the custom to make these taps with a taper of 1 inch per foot.

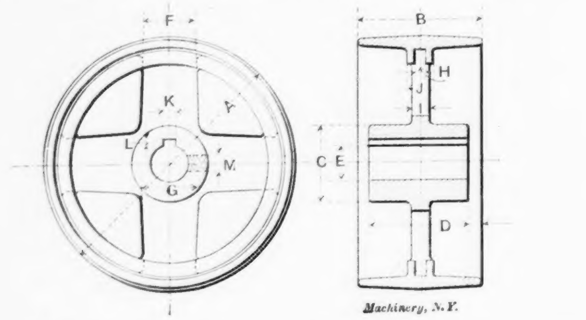
This information should put an end to any question in regard to the taper per foot of Whitworth pipe taps.

Greenfield, Mass. G. W. CARPENTER,
Wells Bros. Company.

NOTES ON HIGH-SPEED PULLEYS.

In looking over some notes the other day I ran across the accompanying sketch and data regarding pulleys, which may prove of interest. These pulleys were designed for fast-running machinery, and finished on both the outer and inner surfaces of the rims, and also on the hubs. The pockets *H*, between the arms, were cored for lead balances, the lead being calked in place as required. The average belt speed was approximately 3,000 feet per minute. The practice of one shop was to place the set-screw on the quarter as shown by the sketch, while that of another was to place it directly over the key. I think the former way the better one as it gives a three-point contact on the shaft, while with the latter method the pulley has but a two-point contact and has a general tendency

TABLE GIVING DIMENSIONS OF PULLEYS AND H.P. TRANSMITTED.



Approx. H. P. Transmitted.	H. P. Transmitted per in width of Belt	A	B	C	D	E	F	G	H	I	J	K	L	M
4	1.58	7½	3	7/8	2 5/8	9/16	1 3/8	1 5/8	1/4	5/16	5/8	5/16	5/32	3/8
8	2.26	8	4	1 1/8	3 3/16	5/8	1 5/8	1 7/8	3/8	9/16	13/16	3/8	3/16	1/2
12	2.64	8½	5	1 1/4	3 5/8	5/8	1 7/8	2	7/16	5/8	15/16	3/8	3/16	1/2
16	3.16	9	6	1 1/2	4 1/8	3/4	2 1/8	2 1/4	7/16	7/8	15/16	7/16	7/32	1/2
24	3.37	11¼	8	1 7/8	5 1/4	1	2 1/2	2 3/4	1/2	7/8	1	1/2	1/4	5/8
32	3.94	12	9	2 1/8	5 9/16	1	2 1/2	2 3/4	1/2	7/8	1 1/4	1/2	1/4	5/8
40	4.40	13	10	2 3/8	7	1 1/8	2 5/8	2 7/8	5/8	7/8	1 1/4	5/8	5/16	5/8
47	4.73	14	11	2 3/4	7 1/2	1 7/16	2 3/4	3	5/8	7/8	1 1/4	5/8	5/16	5/8
63	5.72	17	12	3	8 5/8	1 5/8	3	3 1/4	3/4	1	1 1/2	3/4	3/8	5/8
79	6.58	20	13	3 1/4	10 1/4	1 3/8	3 1/4	3 5/8	5/8	1 1/16	1 1/2	3/4	3/8	5/8

to rock and work. The first column in the table gives the approximate horse-power transmitted by each pulley, and the second column the horse-power transmitted per inch width of belt. It will be noted that the power transmitted per inch of width increases with the size of the pulley and the corresponding thickness of belt; a single belt being used on the first three sizes of pulleys, light double on the next three, and heavy double on the last four. The principal dimensions of the pulleys are given by the table. WM. SANGSTER.

Covington, Va.

SHRINKAGE AND EXPANSION OF STEEL IN HARDENING.

When hardening two tools of the same grade of steel and both of the same dimensions, why will one shrink and one expand? This question has been asked many times by

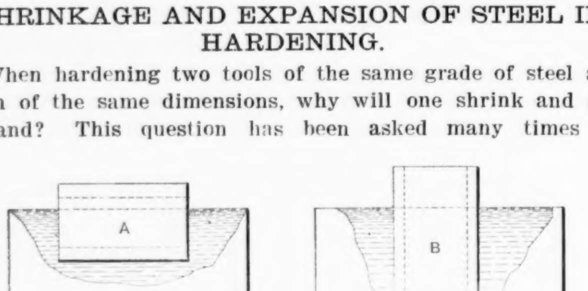


Fig. 1. Methods of Cooling when Hardening, to cause Shrinkage or Expansion.

mechanics. The answer is simply this: they do not receive the same treatment, although the inexperienced hardener is sure that they do. Take, for instance, a couple of small cams, collars, or any pieces at hand, just so they are the same in regard to make and finish, and have the hole in each fit to the same plug gage. Then number them so they will not get mixed in the operation, heat both to the same degree of heat, and dip one as shown at *A*, Fig. 1, and the other as shown at *B*. Put each piece under the water and remove when cold; then try the plug gage. I claim that the piece *A* will not go on, while *B* will fit looser than before heating and dipping.

Not long ago we had a job of shrinking a collar on a shaft that was wanted in a great hurry. When the work arrived in the forge department, the man about to do the shrinking

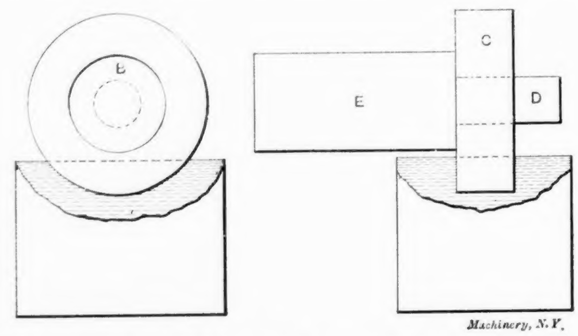


Fig. 2. Method of Shrinking a Collar on a Shaft which is Smaller than the Bore of the Collar.

called my attention to the fact that the collar would already go on the part it was supposed to be shrunk on. Knowing the piece was wanted in a hurry, I told the man to heat the collar *C*, (Fig. 2) to a very low red, and after placing the collar on the end *D* of shaft *E*, to cool it, as shown in the illustration, turning the work rapidly without letting the shaft come in contact with the water, it was impossible to move the collar, when cold, with a good-sized arbor press. Both collar and shaft were machine steel. A great many mechanics have an idea that it is necessary to have the internal piece quite a bit larger than the external piece, but this is not necessary. Of course, if the piece to be shrunk on is large and has a 6- or 8-inch bore, and is of cast iron, it is advisable to leave it 1/64 inch smaller than the internal piece, as cast iron expands more than steel.

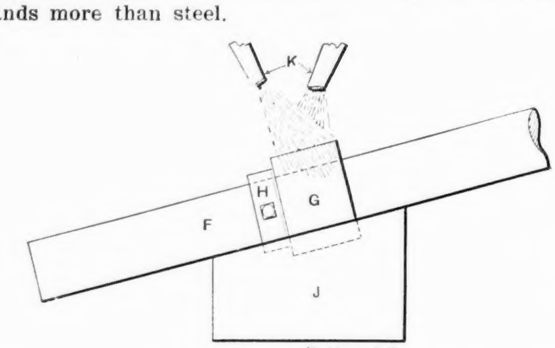


Fig. 3. Arrangement of Cooling Tank when Shrinking Collars on Shafts.

Several years ago I worked for a firm that built saw-mill machinery and tools for repairing all kinds of circular and cross-cut saws. Among the tools was a machine steel shaft about 3 inches in diameter, on which was shrunk a collar of high carbon tool steel. This collar had to be very hard, and after it was shrunk on the shaft, the shaft was turned up and the collar ground. These collars were always bored so as to be shoved on with the hands. In Fig. 3 is shown a shaft *F*, with tool steel collar *G*, and another small collar *H* held by a set-screw. This collar was used to form a shoulder for the tool steel collar *G* to rest against. When shrinking the collar *G* on the shaft, a tank *J* was used, constructed as shown. Another tank having two spouts *K* was arranged above this one. This upper tank was filled with cold salt water and sulphuric acid, there being about one gallon of acid to twenty gallons of water. The collar was heated to about 1,400 degrees F., quickly placed on the shaft in the proper position, and the above solution turned on full force. This chilled the outside of the collar quickly; then the shaft was removed to a tank of oil where it remained until cold. This particular job gave the best of satisfaction.

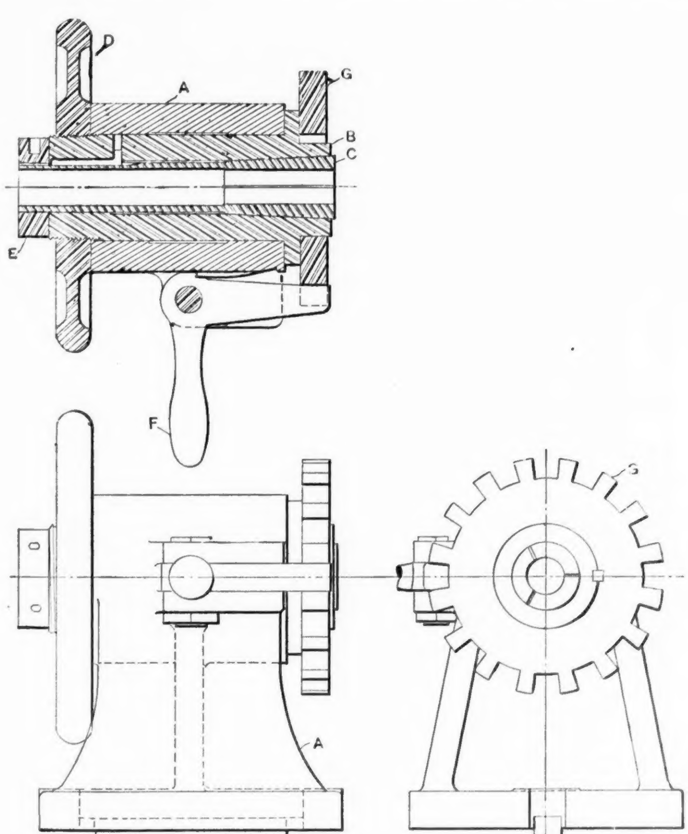
It is very annoying, after making an expensive punch and die, to have them vary in size after hardening. Sometimes

the die will be larger and the punch smaller, rendering them useless. It is a good idea to harden the die first, then leave the punch large enough to grind to fit if it is in such shape as to allow grinding. If a punch is completely cooled in water it will be smaller than if just hardened on the outside enough for the purpose and then removed to oil to relieve itself and cool off slowly. This has been proved to the writer's satisfaction. If the outside of the die is chilled before the inside it will become smaller, but if chilled on the inside before the outside it will be a trifle larger. It is an easy matter to chill the outside first, but the reverse is not so easy. It can, however, be done by covering the outside with asbestos cement before placing in the furnace for heating. I have had punches and dies of large dimensions delivered to me for tempering, and they were in such shape as to be useless if they came out the same as they were before heating; for instance, if the die was too large for the punch, by using a little care, as explained, I was unable after the hardening to place punch inside of die before grinding. This cannot be accomplished by heating and cooling in a haphazard manner, as so many hardeners are apt to do. J. F. SALLOWS.

Lansing, Mich.

SIMPLE INDEXING DEVICE.

In the engraving is shown a device for holding and indexing a spindle, which has, at the middle, a pinion in which the teeth are to be cut. In the particular case in question, the spindle was ⅝ inch in diameter, 20 inches long, the pinion being ⅛ inch in diameter and located 7 inches from one end of the spindle. The spindle was supported by an ordinary center at one end, but the other end was held in the device



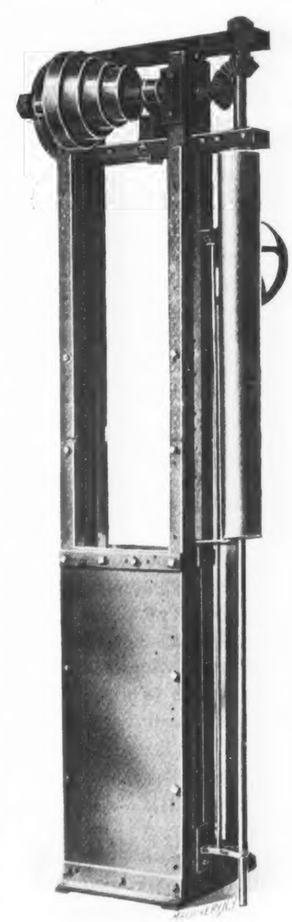
Section and Elevations of the Indexing Device.

shown, by a split chuck C, which was tightened by the nut E at the other end of the head of the device, this nut drawing the chuck through the steel sleeve B. This steel sleeve is keyed to an index plate G, notched on its circumference as indicated, and located in position by the index pawl F. When located, the index plate is clamped by the hand-wheel D, the hole of which is threaded as shown. The sleeve B when not locked by the hand-wheel D is free to revolve in the head casting A. When in operation, the spindle having the pinion to be cut is inserted in the chuck C and tightened by the nut E, the hand-wheel D is loosened, and the pawl F is moved out of the notch in the index plate G, thereby releasing it. By means of the hand-wheel D, which has a tight thread, the index plate is turned to the next notch and then the pawl F is again permitted to enter the notch, locating the spindle in its proper position for the cutting of the next tooth, the hand-wheel clamping the sleeve with the chuck and spindle in position. This operation is repeated for each tooth cut. A great many of these pinions have been cut by this device, and it has been found very satisfactory, as it is quicker and safer to operate than the regular dividing head for this kind of work. J. B. HASKELL.

Hamilton, Ohio.

HOME-MADE MACHINE FOR BORING LATHE SPINDLES.

The illustration shows a home-made machine, designed and built for boring hollow lathe spindles, which has given us satisfaction. We had orders for some 30-inch swing lathes with hollow spindles, 2½-inch hole, and we first attempted to buy a machine in the market that would do this work, but were unable to get hold of one at a reasonable cost that would answer our requirements. The machine shown will bore a 2½-inch hole through a lathe spindle 48 inches long, and do it right.



Home-made Machine for Boring Lathe Spindles.

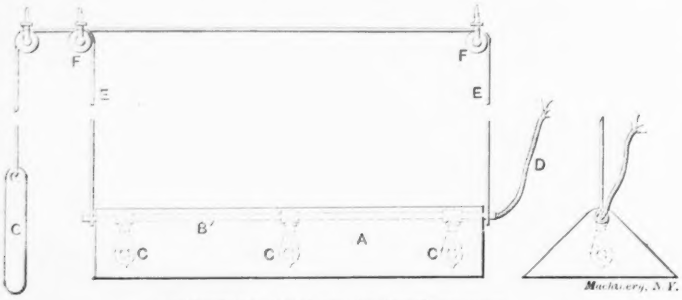
The foundation part of the machine had originally been built for reaming gun barrels. The framework was constructed of ½-inch by 2-inch steel, there being four pieces 10 feet long, with long washers between bolted together, making two parts 12 inches wide. These formed the uprights, both being exactly the same. The two uprights were joined together by a ¼-inch steel plate 20 inches wide, extending from the floor up about 6 feet. This made a very stiff steel frame 10 feet high and 20 x 12 inches on the floor. At the top a 2 x 3-inch steel piece 30 inches long was bolted between the two middle sections of the uprights and extended to one side about 10 inches. Below this and parallel to it was erected a duplicate piece. The two pieces had holes bored through the projecting ends for the vertical spindle on which was mounted a bevel gear, and a screw chuck at the lower end. The horizontal shaft driving the vertical spindle also carries a spur gear of large diameter, and meshing with this is a pinion gear on the cone gear shaft. The spindle to be bored is fastened to the lower end of the vertical spindle and revolves with the shaft, while the drill remains stationary. The drill is fed upward from the bottom and relieves itself of chips by gravity. The feed rigging shows, in the illustration, between the spindle being bored and the frame. It is driven by a belt from the horizontal drive shaft.

Eugene, Ore. ED. B. EBY.

THE LIGHTING OF DRAFTING-ROOMS.

This is a subject often discussed without reaching a satisfactory conclusion for all cases; each one must necessarily be governed by local conditions. In the January number of MACHINERY, an editorial under the above title reminded me of a system used where I once worked. The apparatus is cheap and efficient, and for artificial illumination, when electricity is to be used, has proved to be entirely satisfactory in actual practice.

Referring to the illustration, the shade *A* was made of tin, painted dark green outside, and white inside, through which was passed a pipe *B* with T-connections at *C*. The insulated wires *D* were drawn through the pipe and connected with ordinary 16-candle-power incandescent lamps which were fastened at these T-connections. The whole thing was suspended from the ceiling by cords *E* drawn over pulleys *F*. The cords were attached to the counter-balance *G*, and to the shade as shown, allowing the lights to be raised entirely out of the way when not required, or lowered directly over each board



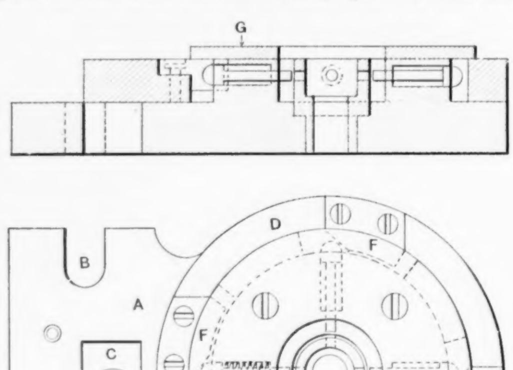
Adjustable Light for the Drafting-room.

sufficiently to shield the eyes of the draftsman and reflect the light over the entire board. The length and number of globes will, of course, depend upon the length of board.

This arrangement may be modified to meet the requirements of the more refined tastes willing to pay for elaborate furnishings. However, the leading features should remain the same: A suspended individual light of wide range, adjustable for height, while permitting the full swing of beam compasses or drafting machine, without encountering supporting brackets. It casts no shadows and protects the eyes of the workman. E. P.

MULTIPLE PIERCING TOOL.

A multiple piercing tool used for thin cup work is shown in the accompanying illustration. This tool can be used for stock from 18 gage down as thin as practicable to work. Of course, it could be made for thicker material, but this would mean very strong springs for stripping the punches, and hard work for the press. The reason I designed this tool was principally to avoid any chance of an accident to the operator's fingers, as in the multiple punches the punch or upper part of the tool covers a large part of the surface of



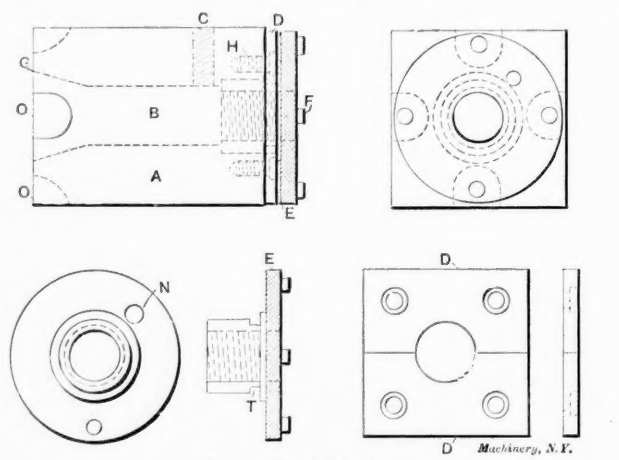
Section and Plan of Multiple Piercing Tool.

the die, thus subjecting the operator's hand to the danger of serious injury when putting the work on or off. This is a point that is not studied as much as it should be in tool design, and it is the duty of every tool designer or person in charge of a machine department to give this matter every attention. Referring to the illustration, *A* is a cast-iron base with two slots *B* for bolting to the bed of the press. A round or square hole *C* is cored through this base, into which the punch enters. A ring *D* having a projecting arm *E* fits over a boss on the base. The arm *E* comes into contact with the punch, which rotates the ring with the cams *F*, which are held in position by two screws. These cams, in turn, operate the four piercing punches and force them into the die. The punches are stripped off the work by spiral springs. A shell die is used so that the scrap from the piercing will fall through. A plate *G* is fastened to the base *A*, which serves to keep the ring *D* in place. A spring (not shown) is attached to the ring *D*, and serves to bring the ring back into position after being rotated by the punch. A plain punch, with a shank to fit the gate or slide of the press, is used. The working end, or the end which comes into contact with the arm *E* is tapered to an angle suitable to the stroke of the press. This style of tool can be designed for perforating almost any number of holes, and, obviously, it can be worked at a high speed with no danger to the operator. CHAS. PETIJEAN.

E. C., London, Eng.

SPRING CHUCK BLOCK.

The accompanying illustration shows a very handy tool for use in the tool-room for slotting screw heads, milling small counterbores, fluting taps, and numerous jobs of like nature. A steel block *A* is machined square, and with all sides parallel to the axis of the hole *B*. The hole *B* is bored to fit the drawn-in spring chucks of the bench lathe. Set-screw *C* engages with the spline on the spring chuck, and keeps it in position while releasing and tightening the work, by the member *E*. Grooves *O* are milled in the face of *A* for cutter clear-



Spring Chuck Block.

ance when milling work of small diameter. The rear end of *A* is counterbored out to receive the member *E*, which is held in place by two plates *D* which fit in groove *T*. These plates are held by four set-screws *H*. Piece *E* has four lugs *F* allowing *A* to be used in a vertical position. Hole *N* in *E* is in line with the set-screws *H*, and it is a little larger than the heads of the screws in plates *D*, thus making an easy job of assembling the parts. As the thread in *E* fits the thread on the spring chucks, it is obvious that when the chuck is in place it may be opened or closed by turning *E* to the right or left. All parts of the chuck block are hardened, it is inexpensive to make, and, with a fair assortment of chucks, makes a nice combination. E. W. NORTON.

North Tarrytown, N. Y.

CUTTING STEEL WITH A BAND-SAW.

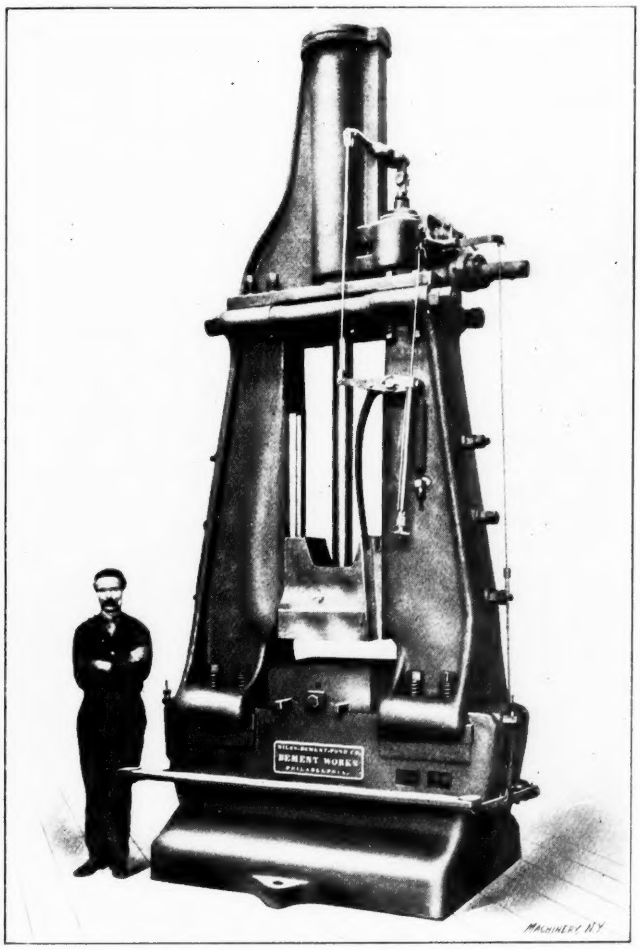
There is a shop on Clinton St., Chicago, that keeps three big band-saws constantly busy cutting tool steel. They do a good business cutting steel for numerous shops in the vicinity, charging seventy-five cents an hour. The band-saws cut very rapidly and accurately and with little waste, only a sixteenth being cut away. A band-saw will cut more than double the amount of steel that a number of common hack-saws costing the same money will do. Another great advantage of a band-saw is that it cuts continually, while a hack-saw only cuts half the time. The steel bars are fed up to the band-saw by a carriage running on slides and moved by weights which are varied to suit the different thicknesses of steel, otherwise the saw frame is practically the same as those used in wood shops, but the saws are made especially for metal.

Decatur, Ill. ETHAN VIALL.

THE DEVELOPMENT OF STEAM DROP HAMMERS.

Attention has been drawn to the article appearing on page 739 (engineering edition), June issue of MACHINERY, headed "Chambersburg Line of Steam Drop Hammers." This publication places the Chambersburg Engineering Co. as pioneers in steam drop hammers, which is very much in error.

Without raising the question as to who was the pioneer, but protesting against the wrong party receiving the credit, I have to make it known that Mr. F. B. Miles, who later became a member of the firm of Bement, Miles & Co., designed in 1872 what seems to be the first steam drop hammer made by his company, and which was sold to the Baldwin Locomotive Works. Since that time this class of machinery has grown to be a large factor in the product of Bement, Miles & Co., and now the Niles-Bement-Pond Company, of which the Bement Company became a part. It was something like a quarter of a century after the date mentioned that the Chambersburg Engineering Co. came into being, and this fact is sufficient for substantiating my claim that the above mentioned company were not the pioneers, for the very good reason that they did not depart in the construction of their



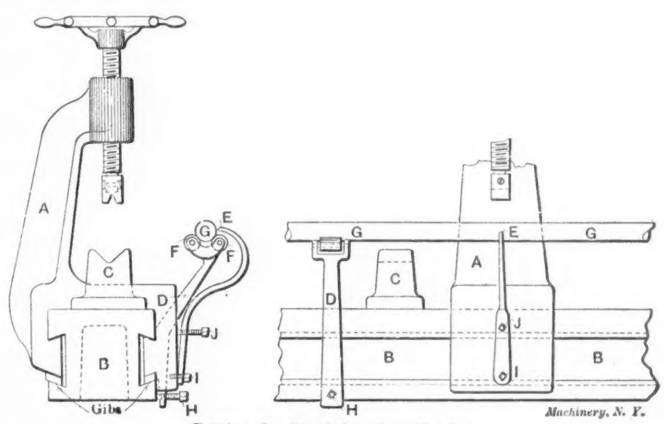
Steam Drop Hammer built by the Niles-Bement-Pond Co.

hammers from the principles involved in the older concern's designs. Since the first hammers were made by Mr. Miles, there has been little change in the important points of construction, such modifications as have been made being simply augmentation, with the vital or working parts as he conceived them. As a proof of the good design Mr. Miles produced, I have to point out that most, if not all, steam hammers manufactured in this country to-day are constructed on the same lines, and the illustrations of them point very strongly to direct copies of what has become known throughout the trade as "Bement hammers." Herewith is an illustration of a steam drop hammer as offered to-day by the Bement Works of the Niles-Bement-Pond Company, and very similar to the one you submitted with the Chambersburg article. The photograph simply shows a growth of the same mechanism produced over thirty years ago by practically the same company, and with no radical differences in principles.

Philadelphia, Pa. W. J. HAGMAN,
General Manager Bement-Miles Works.

DEVICE FOR STRAIGHTENING SHAFTS.

The engraving shows a handy press for straightening. The shafts require no centering in the ends, and can be straightened as perfectly as if they were straightened on centers. The press frame *A* is shown placed approximately at the center of the bed plate *B*, which latter can be made of any length. On the bed plate are placed two supporting V-blocks *C*. The bracket *D* of which there are also two in the complete device, carries hardened rollers *F* on which the shaft is resting while it is being tested by the test needle *E*.



Device for Straightening Shafts.

This latter is secured to the press frame at *I* and adjusted by set-screw *J*. The bracket *D* is dove-tailed into bed plate *B*, but is a loose fit and is secured in position by means of set-screw *H*. The method of operating this device is obvious from the engraving. For rapid straightening it has proved very valuable. The straightening screw is screwed down from the top to give more or less pressure according to how much the shaft needs straightening.

TESTING ROOM.

FLEXIBLE SHAFTS.

A cheap substitute for universal joints or flexible shafts is a helical spring. Effective couplings between the shaft end and spring are shown in the sketches. The shaft is threaded (Fig. 1) for a few turns to a somewhat coarser pitch than that of the spring, and to a somewhat larger diameter at the bottom of the thread than the internal diameter of the spring, with a half-round groove which ends in a drilled hole. The spring has the end bent in toward the center. This end enters the drilled hole on the shaft when the spring is threaded over it. A two-part sleeve threaded internally, the threads having the same pitch as those on the shaft, is screwed over the spring and tightly checked together. The extreme end of the shaft may be slightly tapered and the outer end of the sleeve bell-mouthed so that the spring may not be too rigidly confined at that point. Fig. 2 shows a much cheaper arrangement in which the end of the spring is

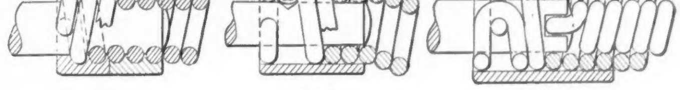


Fig. 1 Fig. 2 Fig. 3

Machinery, N.Y.

Methods of Coupling Springs to Shafts.

looped around the end of a set-screw. Fig. 3 illustrates a method I employ for a flexible shaft using two springs. The outer spring was wound to be a tight fit over the end of the shaft and the sleeve bored to a pushing fit over the spring. A taper pin fastened the sleeve and spring to the shaft, the free end of the spring being brought around back of the taper pin to form a hook. The inner or core spring is made as large as will draw freely into the outer one, and has its ends formed into loops which engage the slotted end of the shaft. The two springs are wound opposite hand so that the torsion tends to close in the outer one and open out the inner one. Arranged in this manner the shaft is very effective and is cheaply constructed. GEO. W. ARMSTRONG.

Norwich, Conn.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

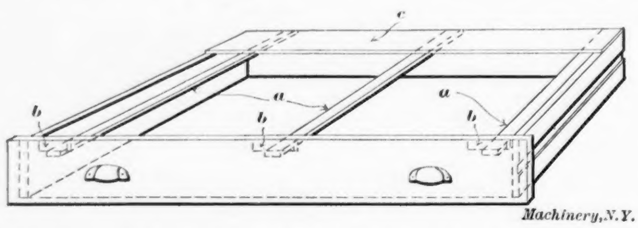
FIBER WEDGE FOR SECURING HAMMER TO ITS SHAFT.

A wedge made of fiber, particularly of the hard quality used for washers on automobiles, is an excellent substitute for the wood or steel wedge that ordinarily secures a hammer head to the handle. DONALD A. HAMPSON.

Middletown, N. Y.

DRAWER FOR DRAWINGS.

A simple and cheap method of making drawings lie flat in drawers is shown in the accompanying engraving. It consists of three blocks *b* fastened to the inside of the front of the drawer, a back top *c*, and three slats *a*, which are slipped

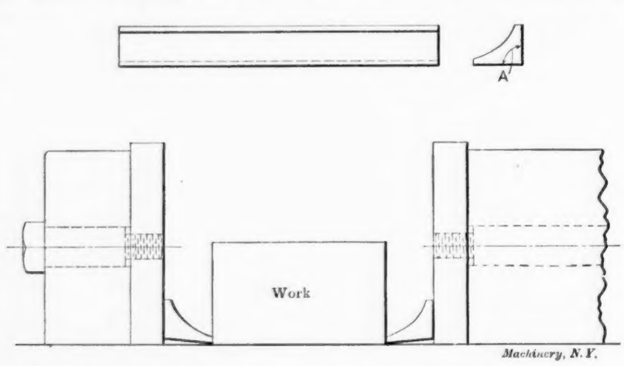


in under *c* and *b*. These slats keep the drawings from curling up and catching in the drawer case. By using a drawer of this description, the capacity is increased from three to four times. JOHN B. SPERRY.

Aurora, Ill.

CLAMPING APPLIANCES FOR THE PLANER.

The illustration shows a pair of handy hold-downs for holding work in the vise of a planer or shaper. A detailed view of the appliance is shown above clearly indicating how it is made. The angle *A* should be slightly more than a right



angle, so as to prevent the clamping piece from bearing on its bottom surface when used. These clamping pieces are especially handy for clamping thin pieces. The engraving plainly shows how they are used. C. W. R.

TOOL-MAKERS' DRILL PAD.

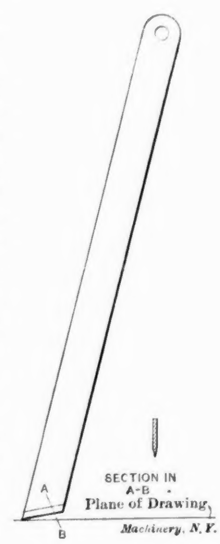
The engraving shows a simple device, made of leather, for carrying drills back and forth from the bench to the drill press, instead of using the ordinary drill block. It struck

me as being a very convenient and compact way of taking care of a set of drills. Most tool-makers know how handy it is for anyone to come along and pick out a drill from the ordinary drill block on the bench and return the drill in a very poor condition. I would make one improvement to the drill pad, and that would be to rivet a small piece of brass where each drill is placed and stamp the number of the drill on; then any drill could readily be selected. This drill pad can be rolled up and stuck in the pocket, which makes it mighty convenient when one has some heavy tool or jig to carry to or from the drill press. A. J. DE LILLE.

Minneapolis, Minn.

REMOVING INK FROM DRAWINGS.

One of the best tools for removing ink from a drawing, before using a rubber eraser, may be made from a worn-out hack saw blade. The accompanying illustration shows such an instrument. About six inches is broken off one end of the blade, the teeth are ground off, and the broken end is sharpened as shown. This end should be ground very thin, and on one side only. To prevent cutting the drawing, the edge is rounded slightly at the extreme point. Not every hack saw blade, however, will make a good scalpel. The blade should be evenly tempered from the teeth to the back, if possible, and no retempering will be necessary. To use the tool, hold it between the thumb and first finger, so that the edge is almost parallel to the surface of the drawing, but touches it at the point only.

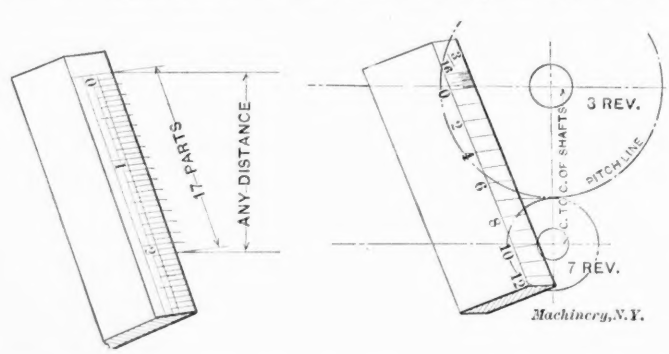


Detroit, Mich. A. L. CAMPBELL.

THE USE OF THE ORDINARY RULE FOR DIVIDING.

The operation of dividing a line into any number of equal spaces is a very simple one, and one of the first exercises in geometry, but however familiar men might be with its execution, I have rarely seen anyone use the rule for this purpose. When it is required, for instance, to draw a certain number of lines or a certain number of threads per inch, in a given space, sometimes the length of the single spaces will be figured, or a diagonally drawn line will be spaced off with the dividers and the spaces transferred with the triangles.

The shortest way is to use the ordinary or draftsman's scale. Use the graduation, nearest suitable to the eye, place the zero mark on one end of the space to be divided, and the number corresponding to the parts required on the line marking the end of the space, or its continuation, mark off points at every graduation, and with triangle or T-square draw parallel lines through these points. At the left is shown two lines, the distance between which is to be divided into 17 equal parts. In this case the regular scale of an



ordinary rule is used; after the points are marked off, parallel lines are drawn through them. This use of the rule for dividing without going to the trouble of figuring is applicable in a great number of cases. The distance center to center of two shafts is given, and a transmission of spur gearing of the ratio 3 to 7 between them is wanted. The pitch circles can be drawn immediately without figuring their diameters or number of teeth. Draw the distance between centers to scale, hold the zero mark of rule on a line through one center and the graduation 10 (= 3 + 7) to a parallel line through the other center; the graduation 7 marks the line tangent to the two pitch circles, as illustrated in the right-hand view. MARTIN JOACHIMSON.

New York City.

FINISHING FLY-WHEELS, HOIST DRUMS AND PISTON RINGS ON THE LIBBY TURRET LATHE.

An illustrated description of the Libby turret lathe appeared in the March issue of MACHINERY. In this description some of the characteristic features of its design were pointed out; one of the most interesting features there called attention to was the unusual construction of the tool-post carriage. This carriage does not extend across the bed, as in the usual designs of this class of machines, but it is supported by a front

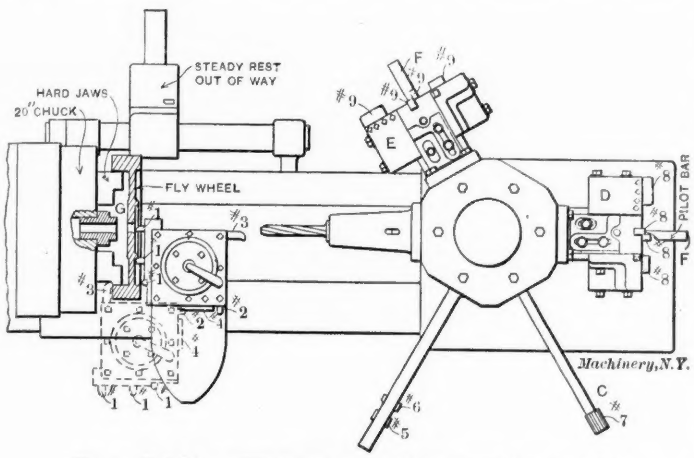


Fig. 1. Finishing a Fly-wheel in the Libby Turret Lathe. First part of First Operation.

way and by a V-guide at the bottom of its apron, bearing on a corresponding way on the lower edge of the bed. This permits the tool-post carriage to be moved past the chuck mounted on the spindle at the head-stock end. The turret can thus be used close up to the chuck, and overhanging tools, usually required to reach over the tool-post cross slide, can be avoided. Another advantage gained is also that, on account of its construction, practically the full capacity of the machine can be swung over the carriage.

In the present article a number of interesting operations, as performed on this machine by the International Machine Tool Co., of Indianapolis, Ind., are described. The operations which we will here deal with are the finishing of automobile fly-wheels, in two settings, the finishing of hoist drums, and the making of piston rings.

Finishing Automobile Fly-wheels in Two Settings.

The finishing of automobile fly-wheels on the Libby turret lathe is illustrated in the three line engravings, Figs. 1, 2, and

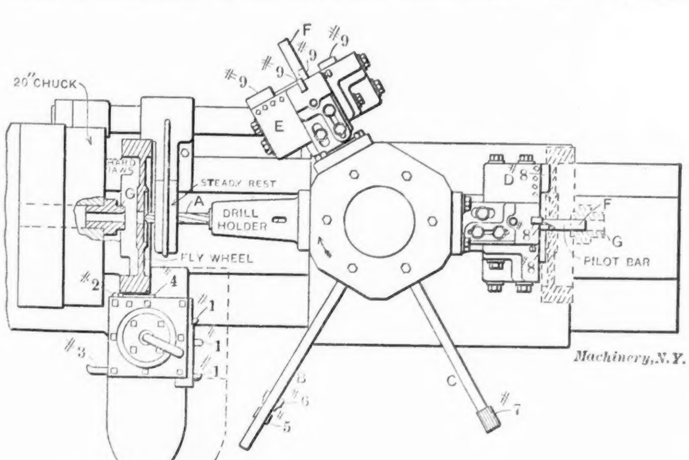


Fig. 2. Finishing a Fly-wheel in the Libby Turret Lathe. Second part of the First Operation.

3. The fly-wheel is chucked from the inside by the hard steel jaws of the chuck, sufficient space being left between the chuck and the rim of the fly-wheel so that the tool for facing the back side of the rim of the wheel will have ample clearance, as shown by the dotted lines in Fig. 1, where tool No. 3 is indicated as finishing the back side of the rim.

The gang tools No. 1 are now set as shown in Fig. 1, and the tool-post carriage is brought into position, as shown, so as to rough all the faces at one operation. The tool-post carriage is next brought into position, as shown in Fig. 2, permitting the use of tool No. 2 for roughing the outside diameter of the fly-wheel. The steady-rest, which was swung out of the way in Fig. 1, is brought into position for supporting the drill and boring-bar used for the hole in wheel in Fig. 2. This hole is being drilled and the rim of the wheel rough-turned, simultaneously. The cutter bar *B*, with cutters Nos. 5 and 6, is then used to bore the hole in the fly-wheel preparatory to reaming by reamer No. 7.

When the center hole is reamed, the roughing facing head *D* is brought into position. While the roughing head *D* is in operation, the tool-post carriage is placed in position so as to use tool No. 3, as shown by the dotted lines in Fig. 1, already referred to. This tool then rough-turns the rim of the fly-wheel next to the chuck. Finally, the finishing facing head *E* with the tools No. 9 is brought into position to be applied to the work, and the tool-post carriage at the same time set so that the broad finishing tool No. 4 finishes the outside diameter of the wheel, as shown in Fig. 2. The cutters Nos. 8 and 9 in the heads *D* and *E* are adjustable to cuts of various sizes and depths, within the range of the holders. The pilot bars *F* on the facing heads *D* and *E* are employed to steady the heads while in action, the pilot bars receiving their support from the bushing *G* in the chuck.

One side of the fly-wheel is now finished. For the second operation the wheel is held by the outside finished rim by soft jaws, as shown in Fig. 3. The gang tools No. 10 in the tool-post carriage are then used for rough-turning the web of the wheel. After that, the roughing head *D* and the finishing head

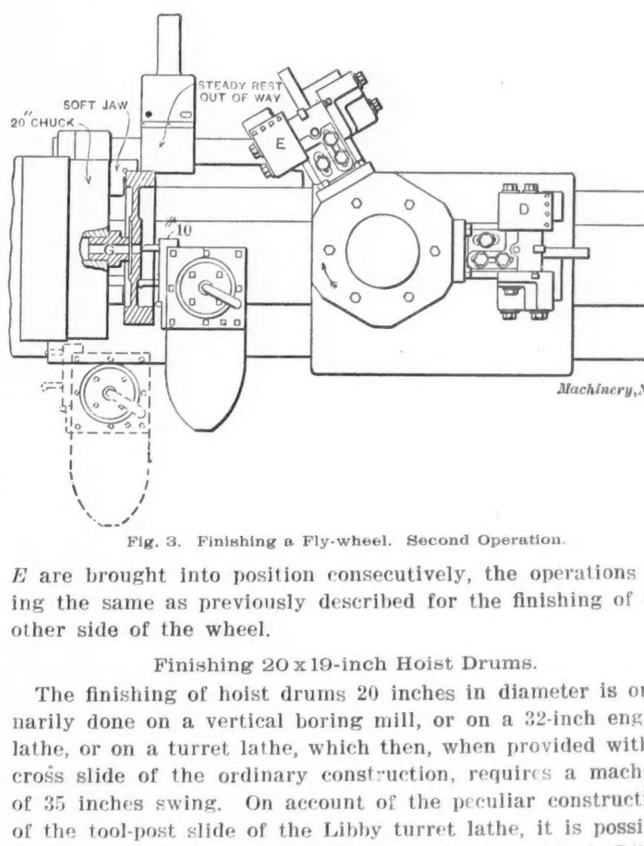


Fig. 3. Finishing a Fly-wheel. Second Operation.

E are brought into position consecutively, the operations being the same as previously described for the finishing of the other side of the wheel.

Finishing 20 x 19-inch Hoist Drums.

The finishing of hoist drums 20 inches in diameter is ordinarily done on a vertical boring mill, or on a 32-inch engine lathe, or on a turret lathe, which then, when provided with a cross slide of the ordinary construction, requires a machine of 35 inches swing. On account of the peculiar construction of the tool-post slide of the Libby turret lathe, it is possible to finish drums of the size mentioned in a 21-inch Libby lathe, at one setting, the operations performed being the boring and reaming of the holes in the two hubs, the facing of one hub, the turning of the outside diameter of the drum, and scoring the drum for the rope as shown in Fig. 4.

The drum is chucked from the inside of the rim, the holes in the hubs are rough-turned by the boring-bar *A* and finish-bored by the boring-bar *B*. The tools Nos. 5 and 7 are for boring the holes in the hubs, and Nos. 6 and 8 are for facing. After boring, the holes are reamed with reamer No. 9 on bar *C*. It should be noted that bar *C* is long enough so that the projection reaches through the drum and acts as a pilot bar, the further end being supported by the bushing *F* in the chuck, this insuring true alignment of the holes when reamed.

The steady bar or arbor *D* is now brought in position into the reamed holes in the drum. The large diameter of this bar fits closely the reamed holes in the hubs, and the small

part *E* is of such a size that it will fit the bushing *F* in the chuck. This bar supports the drum while turning and scoring it on the outside. The advantage of being able to bring the turret close up to the work, on account of the peculiar construction of the tool-post slide, already referred to, is here plainly in evidence. The supporting bar can be made correspondingly short, and will consequently be more rigid, the turret being brought up very close to the end of the drum. The drum and brake band is now rough-turned with tool No. 1, and finished to size with tool No. 3. After that the edges on the flanges are rounded off with tool No. 4. Finally, tool No. 2 is used for scoring the drum to the required pitch, which, in this case, is one inch lead. Other leads may, of course, be obtained by simply changing the change gears. The four last-mentioned tools are all mounted in the tool-post carriage, as shown in Fig. 4. The position of this carriage as indicated by the dotted lines should be noted, the carriage in this case being opposite the chuck on the spindle.

This particular drum only requires the facing of one hub. If the other hub is required to be faced, this may be done by placing a cutter in the bar after it is inserted into the holes, provided that sufficient room is left for the cutter when the drum is chucked.

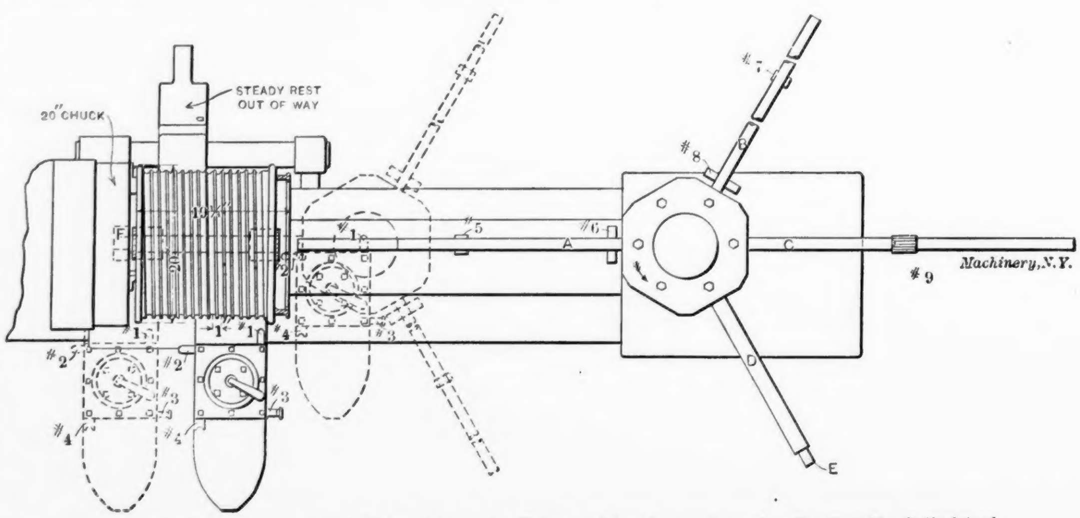


Fig. 4. Boring and reaming the Holes, facing the Hubs, and turning and scoring the Outside Cylindrical Surface of a Hoisting Drum, in One Operation.

Making 18-inch Piston Rings.

In Fig. 5 is shown the method and tools used for making 18-inch piston rings on the Libby turret lathe. The line engraving shows the piston ring casting, which has had the lugs faced off, and is bolted to a shifting face-plate of the eccentricity desired in the rings. This face-plate, in turn, is fastened to the chuck after removing the jaws. Tool No. 1 in the tool-post carriage is used for roughing off the outside of the rings, and tool No. 2 for finishing. Then the shifting face-plate is adjusted so as to provide for the eccentricity desired in the rings. Now the roughing cutter head *A* is brought into action for roughing the side of the ring, it being followed by the finishing cutter head *B*. Each of these cutter heads has four cutters and is also provided with a pilot bar long enough to reach through the ring and engage with the bushing *C* in the chuck, thus providing for rigid guiding.

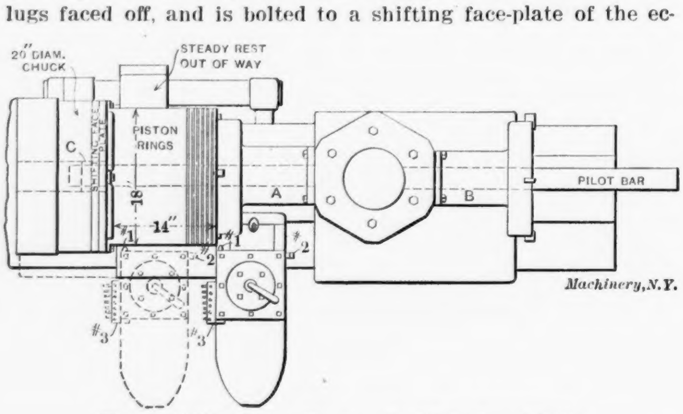


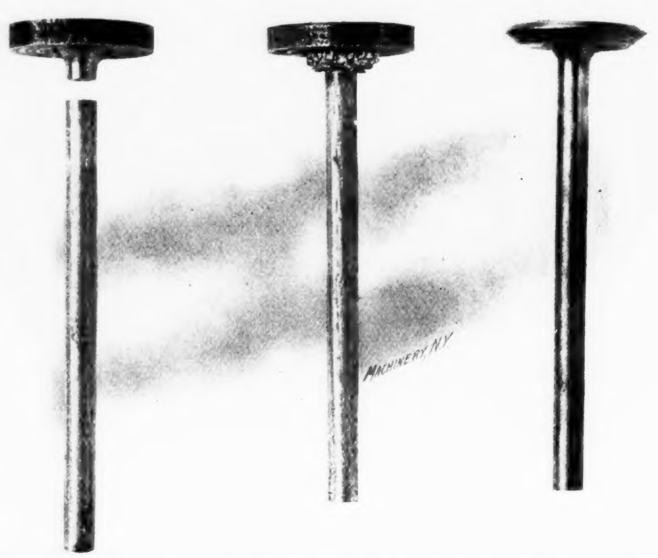
Fig. 5. Making Piston Rings on the Libby Turret Lathe.

The gang tool No. 3, mounted in the tool-post, is now brought into service. This gang tool is provided with seven cutting-off tools, and so arranged that each cutter, commencing at the right, is set slightly in advance of the one to the left. The longest, or the extreme right-hand cutter, is used as a gage, and will cut off its ring first; then each ring will be cut off in turn, and not all at once. As the inside of the ring is bored true with the spindle and the outside is eccentric, the tools will cut through and cut off the ring all around at the same time.

ELECTRIC WELDING OF DISSIMILAR METALS.

In the April, 1908, issue, examples of electric welding were illustrated, and the various electric welding processes were briefly described. A valuable feature of the Thompson process of electric welding is that the dissimilar metals can be perfectly joined. This possibility permits combination of metals best suited to the conditions of use to be made, as well as very substantial economies in the use of high-priced materials. The accompanying illustrations show specific examples of electric welding of dissimilar metals done by the Electric Welding Products Co., Cleveland, O., formerly the Cleveland Cap Screw Co.

The poppet valve shown in Fig. 3 is one of the exhaust valves of a high-speed gas engine. It is made up of a carbon steel stem, electrically welded to a nickel steel head. The parts before welding are shown in Fig. 1, and the combination immediately after welding in Fig. 2, while the finished valve is illustrated in Fig. 3. By making the head of nickel steel, of an alloy suited to the purpose, the very best metal is put in the head of the valve, which is the part subjected to the hardest usage. Nickel steel is peculiarly suited to the trying conditions surrounding gas engine exhaust valves, as it does not pit, warp nor corrode, as does common steel in such a situation. Moreover, it is much tougher, and is not apt to break because of the hammering it receives. The stem, being made of carbon steel stands wear in the guide better than a nickel steel stem; it is stiffer also and can be hardened on the end. The latter consideration is important, inasmuch as high percentage nickel steel cannot be satisfactorily hardened to withstand the cam blow of the valve mechanism. Another important advantage of the combination is the saving of high-priced metal and the obvious



Figs 1, 2, and 3. A Poppet Valve made by electrically welding a Carbon Steel Stem to a Nickel Steel Head.

saving of labor over that required for making and machining a forging.

The cap-screw illustrated in Fig. 6 is made with a brass head and steel body. Figs. 4 and 5 show the parts of the welded screw before finishing. This screw is 50 per cent

Figs. 4, 5, and 6. A Cap-screw made by electrically welding a Steel Body to a Brass Head.

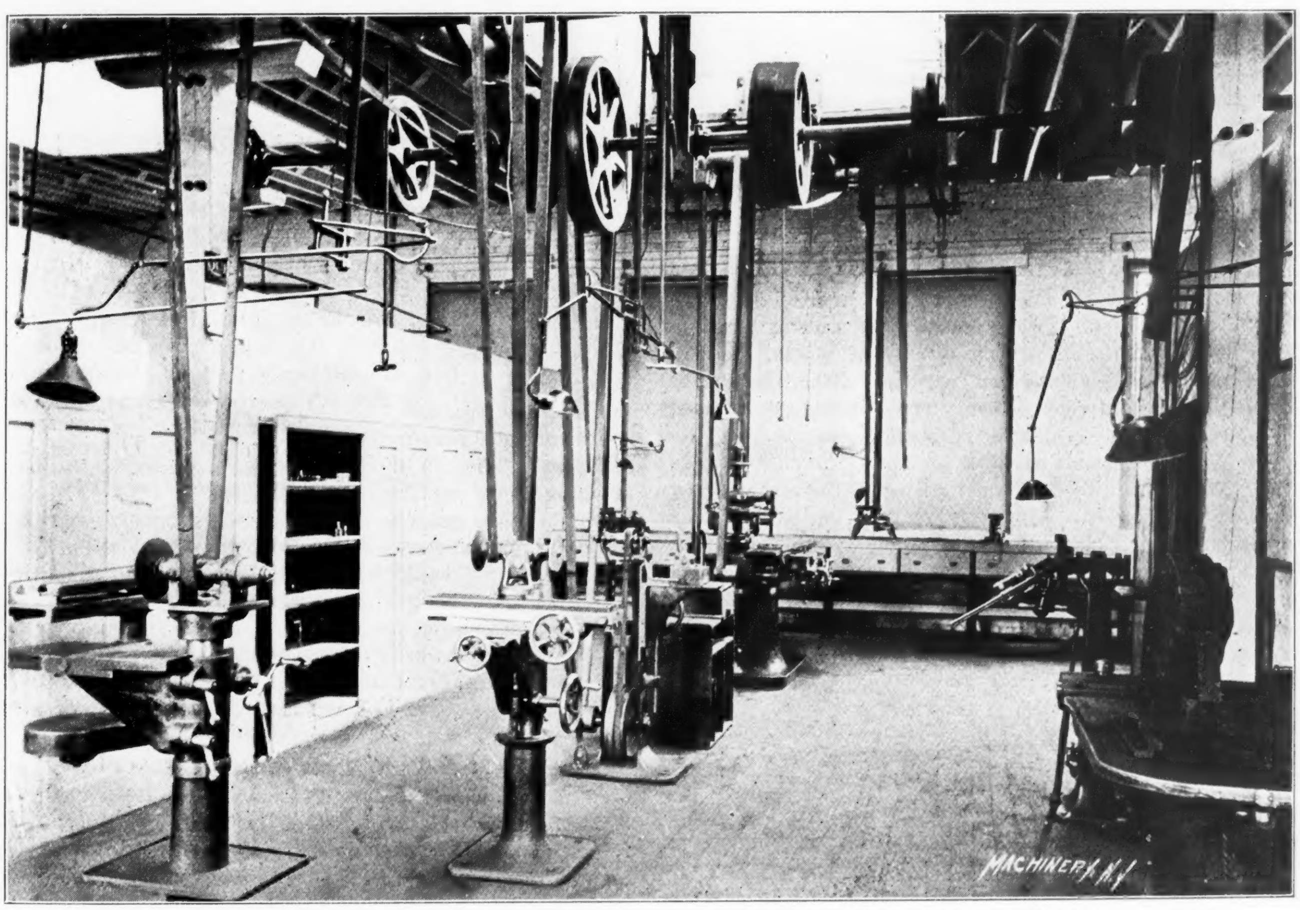
stronger than an all brass screw, and answers the practical requirements equally well or better, inasmuch as the body is stronger than a brass body. This combination was made for use in places where an ornamental finish was required, and as the head only shows, a brass body was not required.

made of electric welded cap-screws and cap-screws made by twelve makers, from ordinary stock. The tests show that the average tensile strength of ½ to 1¼ inch electric welded cap-screws was 97,862 pounds per square inch, while the average of the ordinary stock screws was only 56,570 pounds per square inch. The difference in favor of the electric welded screws was 73 per cent.

As indicated in the foregoing, the process employed by the company is the Thompson process, which is believed to have advantage over the arc, forge and gas blowpipe methods. In the Thompson process the metals are heated for welding by their resistance to the electric current. The parts are gripped in copper-faced jaws of the welding machines, and in the case of large parts are forced together by hydraulic pressure. The interior of the parts heats first, and when the surface has reached the incandescent point, the interior has surely reached the proper welding heat. The great heat generated burns out all oxides and impurities, and the pressure exerted causes the joint to flow and brings the parts into intimate contact; thus only ordinary care is required on the part of the operator to make perfect joints.

INDIVIDUAL MACHINE LIGHTING.

The accompanying engraving shows the grinding room of the H. Mueller Mfg. Co. and the form of lamp brackets used. An ordinary pipe flange is fastened to the ceiling or to the hanger boards and into this a pipe of suitable length is



Grinding Room of the H. Mueller Mfg. Co., equipped with a Simple Form of Adjustable Lamp Bracket.

Other valuable combinations of dissimilar metals could be mentioned, but the foregoing will serve to illustrate the advantage of electric welding in this line. The chief business of the company is the manufacture of all sorts of steel bolts and screws, and it has been engaged in it for several years. The claim made for electric welded all-steel bolts and screws is that they are stronger than when made by the ordinary methods. The reason is that the die-drawn surface of the stock is retained on the body, this portion of the body being much stronger than the center which is left when the bar is turned down to the body size from the head size. In the case of forged bolts this objection, of course, does not hold, but it is common practice to use inferior grades of stock which are unreliable in service. This fact is indicated by tests

screwed. A cast iron bracket is slipped on the lower end of this and held in place by a set-screw. The bracket arm can be swung in a horizontal plane, and the pipe extension which has a circular end passing through a hole in the end of the arm, can be moved in any direction, horzontally or vertically, and is held in place by friction only. There is also a wall bracket used, as shown over the bench near the windows. Both the clamshell and bell shades are used, according to the individual liking. For this photograph and description we are indebted to Mr. Ethan Viall, Decatur, Ill., who says that the fixtures are ahead of anything that he has seen.

* * *

Most people would know more if they didn't take so many things for granted.—*The Silent Partner.*

MACHINE SHOP PRACTICE.*

GRINDING A GEAR-CUTTER.

Experience has taught the advisability of keeping keen cutting edges on all tools, whether used for working in wood or metal; and milling cutters, in particular, when in constant use, should be sharpened frequently, as a cutter with a keen cutting edge is the one that will produce the best results, both as to the quantity and quality of the work. When a cutter becomes dull, it rapidly becomes worse, the friction is greatly increased, and the resulting heat often impairs the temper of the tool, with the result that the cutting edges are

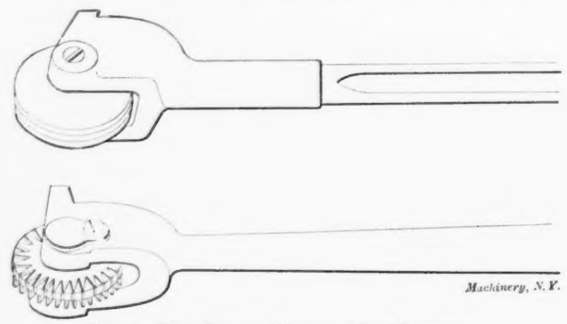


Fig. 1. Two Types of Emery-wheel Dressers.

rounded, which means considerable grinding in sharpening. More power is, of course, required for driving dull tools, and the wear and tear on the machine is also increased.

The gear-cutter which we are considering is a cutter of the formed type, which may be re-sharpened without changing its profile, provided the sharpening is done properly. The first thing which is essential in connection with any grinding operation is a true wheel, as an untrue wheel is not only a source of danger, but the work done by it poor in quality. The diamond, which is the hardest known substance, is best adapted to this work, owing to the hardness of the abrasive materials used for grinding. When the wheels are large and coarse, this method is somewhat expensive, and tools known as emery dressers are often used. Two types of these tools in common use are shown in Fig. 1. They consist of shanks, having mounted on a spindle on the end, hardened disks, the shapes of which vary in different makes. These disks are brought into contact with the wheel, and traversed across its face. As they revolve rapidly small particles of the abrasive are broken from the wheel's periphery, and it is trued. A diamond truing tool, which is extensively used, especially on small wheels, is shown in Fig. 2. It consists of a shank *A*, having a handle on one end and a small diamond *B* set in the other. This tool is applied to the wheel in various ways. Holders, similar to the one shown on Shop Operation Sheet No. 67 of the Supplement accompanying this issue, are often used, but some oper-

Fig. 2. The Diamond Truing Tool.

ators prefer to support the tool on the foot-stock center, truing the wheel by traversing it or the table back and forth. A diamond of good quality will stand much use without showing any great amount of wear, but because of its brittleness, it should be brought very gradually to the face of the wheel to avoid the shock which would be the result of a sudden application.

The selection of a wheel suitable for grinding cutters is governed largely by conditions. Wheels which work satisfactorily on cutters made from carbon steel, are not so well adapted for high speed steel, which is ground with better results with a coarser and softer wheel than is used for the carbon steel. A wheel of medium fine grit, and medium or soft grade is best adapted for cutter grinding. Grit as used here refers to the size of grains of the abrasive, while grade is the degree of tenacity with which the bond holds the grit in place. For this particular operation a wheel having a beveled side, as shown in Fig. 3, is necessary in order that it may clear the work when grinding the inner faces of the teeth. If the working surface of the wheel is glazed, this should be removed with the diamond before using, as otherwise, the temper may be drawn from the teeth of the cutter, owing to the increased friction. Glazing can also be removed by a carborundum crystal, which is only inferior to the diamond in hardness. A glazed surface on the wheel does not necessarily mean that it is not adapted to the work, as oil or grease on the cutter is often the cause of this.

* With Shop Operation Sheet Supplement.

When the gear-cutter is being ground it is mounted on a fixture, similar to the one shown on Shop Operation Sheet No. 68. A stud on the fixture fits a hole in the cutter, which is kept from turning while being ground by a tooth-rest which bears against the backs of the teeth. The knee of the grinding machine is adjusted vertically until the axis of the wheel lies in a plane midway between the sides of the cutter. The table is also adjusted until the axis of the stud on which the cutter is mounted is in line with the grinding face of the wheel. It is very important that gear-cutter teeth be ground radially, or so that the faces of the teeth lie in a plane passing through the axis of the cutter. In Fig. 3 is shown the correct and incorrect way of grinding the teeth. As will be seen, the face of the tooth *A* is on the radial line, while tooth *B* is not. Teeth not ground radially, if sunk to the correct depth in the gear blank, cut a tooth space which is wide at the top, and the result is, of course, a gear having improperly shaped teeth which means that it will work unsatisfactorily. One reason why teeth are not ground radially is because they are thinnest at the top, and because of this are sharpened in less time by grinding them away faster at this point. This is, however, bad practice, for while the cutter may appear sharp, it will not only produce inaccurate work, but cut badly, owing to the negative rake. As the wheel contact on a gear-cutter is considerable, owing to the width of the teeth, it is inadvisable to attempt to do the work rapidly by taking heavy cuts, as this will result in drawing the temper of the cutter. Light cuts should be taken, and the work traversed rapidly across the wheel.

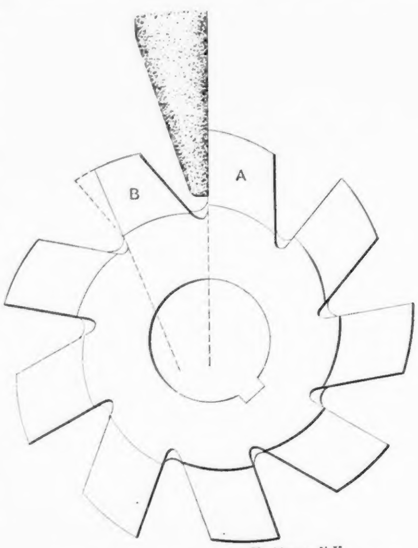


Fig. 3. Correct and Incorrect Methods of Grinding Gear-cutter Teeth.

* * *

In a recent address to a university student body in a Canadian town, Rudyard Kipling said, "*Take everything seriously and earnestly, except yourselves.*" What a wealth of meaning there is in those few words! Doubtless there is no other fault more prominent in the average college graduate than an exaggerated idea of his own importance. He confidently expects to step from his college work to a place all prepared for him, and fittingly compensated as his great ability deserves! In the language of the street, he usually has a "swelled head." The chief part of the first few years of his practical education, which we call experience, is largely learning his relative unimportance to the world at large. The engineering student learns with much disgust that many of the beautiful theories so carefully and positively expounded by his instructors apply only in the remotest degree to his actual work. He finds that engineering is nine-tenths plain hard work on common-sense matters, and that his theoretical knowledge may apply to some extent to the other one-tenth. His knowledge of theory is not nearly so important as his personality and general attitude to his fellow employes.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

POTTER & JOHNSTON 6-INCH AUTOMATIC CHUCKING MACHINE.

The readers of MACHINERY are familiar with the Potter & Johnston chucking machine from the very complete description we have recently given of it. (See article "The Setting Up and Operation of the Potter & Johnston Automatic Chucking Machine," in the April and May, 1908, issues, and "New Machinery and Tools" in the April, 1908, issue.) The builders of this machine have recently added to their line a smaller size which they designate as their 6-inch automatic chucking machine. This is shown in the three accompanying engravings. While it involves the same principles in its construction as used in the larger machine, the actual mechanism employed is different in a number of particulars, and is of sufficient interest to warrant the full illustration and description herewith given.

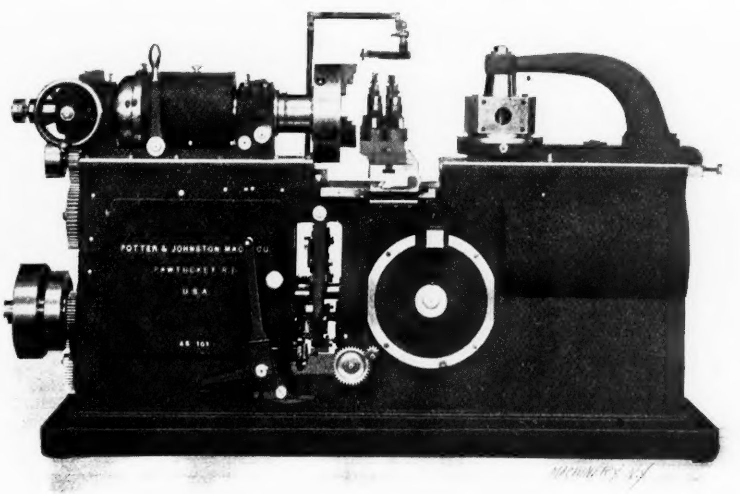


Fig. 1. A Small Size and New Design of the Potter & Johnston Automatic Chucking Lathe.

General Description of Machine.

The plan of the machine is very simple, consisting, as it does primarily, of a single bed casting with an adjustably mounted head-stock and driving mechanism on one end, and turret slide on the other, with longitudinal ways between them on which the base for the double-acting cross-slide is adjustably mounted. The cross-slide and turret-slide are operated by cylindrical cams, driven from a feed shaft at the rear of the machine, which also operates the governing disk seen in the opening in the center of the bed. This disk carries dogs and pins which control the rapid and slow movements of the feed shaft, and the spindle speed changes, of which there are three, controlled automatically. The slow or feeding movement of the feed shaft is operated from the spindle movement, and is proportional to it. The rapid movement is operated from the constant speed driving pulley, and always runs at the highest practicable speed. A large supply of gears, both for speeds and feeds, is provided, covering all ranges of work within the capacity of the machine.

A front view of the machine is shown in Fig. 1. A notable characteristic, which will at once be seen, is the completeness with which the mechanism is enclosed in the single rectangular box-shaped casting. Another feature which catches the eye is the provision made for the longitudinal adjustment of the head-stock to suit work of different lengths. This has been done in preference to making this adjustment between the cam roll and the turret slide, as it is thereby possible to make the parts with less over-hang, and so give the machine greater rigidity and greater cutting power.

Spindle Driving Mechanism.

The machine is driven from a constant speed pulley at the base of the machine, seen at A in Fig. 3. This pulley is keyed to shaft B, which runs through the head-stock end of the base, and carries a set of three gears, C, D, and E, of varying diameters, meshing with corresponding gears F, G, and H, running loosely on short shaft J above it. The largest of these gears, F, is connected with shaft J by a roller ratchet mechanism, so that the drive is normally through this pair of gears, C and F. The other two sets are provided with clutches, either one of which can be thrown into operation, as will be described later. When either of them is engaged, shaft J, thus driven at a faster rate than that given by its normal connection through gear F, runs away from that gear, being permitted this liberty by the roller ratchet drive. It will thus be seen that three changes of speed are provided for shaft J by the operation of two positive clutches.

Shaft J is connected by change gearing K and L with a shaft M above it, which extends out through the back end of the bed, where it carries gear N, which drives a mating gear O, keyed to a shaft running lengthwise of the head-stock, between the ways on which the latter is adjusted. This shaft carries a pinion which engages the driving gear of the spindle. The shaft is splined a sufficient length to give a full drive on the pinion at any adjustment of the head. The change gears K and L furnished for connecting shafts J and M in the base, provide for six rates of speed, which, with the three clutch changes available, gives eighteen changes in all.

Handle P on the head-stock controls a double-acting clutch which engages the spindle with either the driving gear on one side, or with a stationary brake member on the other. This is a great convenience and a time saver as well, since it enables the operator to stop the spindle instantly for the purpose of removing and inserting work. Hand-wheel Q at the rear bearing of the spindle operates a rugged back facing attachment, consisting of a stiff stationary bar supported from the back end and extending the length of the spindle with a facing tool on the front, by means of which the inner hub of work held in the chuck may be conveniently finished.

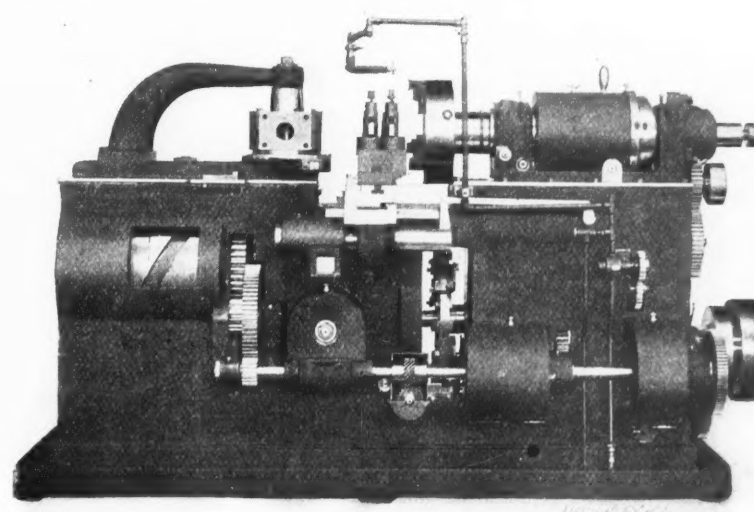


Fig. 2. Rear View showing the Feed Shaft and its Connections with the Governing Disk and Cross- and Turret-slide Cams.

Driving Connections of the Cam and Governing Mechanisms.

The feeding movement for driving the cross-slide and turret-slide cams is driven from pulley R at the rear end of the driving pinion shaft, so that it always revolves proportionally with the spindle, thus making all feeds proportional to the

spindle speed. The conditions are thus the same as in the lathe, where the number of revolutions per inch of feed is constant, whatever the rate may be at which the spindle revolves. Pulley *R* is belted to pulley *S*, which runs loosely on shaft *B*. Change gearing connects this pulley *S* with the feed shaft seen in Fig. 2, running along the back of the bed near the base. This feed shaft has also geared connections with constant speed driving shaft *B*, which connections are controlled by the vertical lever *T*, see Fig. 3. By means of this lever, the motion of the feed shaft may be arrested entirely, it may be given the constant speed rapid movement from shaft *B* required for the idle motions of the machine, or it may be connected with the spindle for the cutting movement through pulley *S* and the gearing just described. These changes may also be made automatically, as will be described later. The considerable reduction required for the feeding motion between the loose pulley *S* and the feed shaft at the

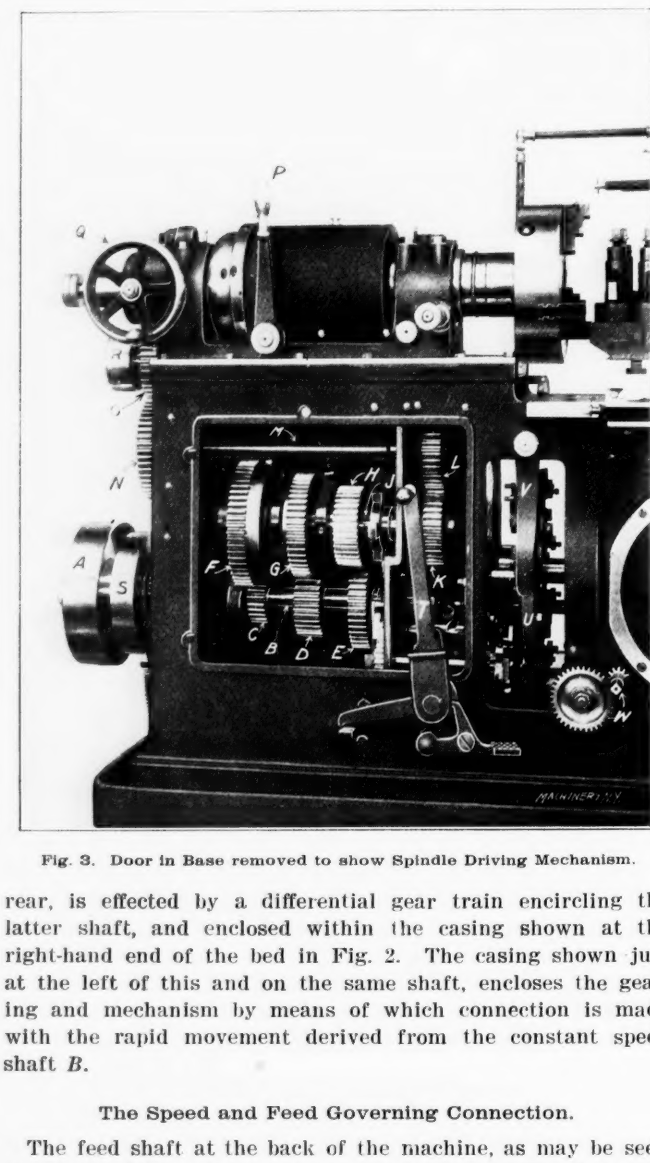


Fig. 3. Door in Base removed to show Spindle Driving Mechanism.

rear, is effected by a differential gear train encircling the latter shaft, and enclosed within the casing shown at the right-hand end of the bed in Fig. 2. The casing shown just at the left of this and on the same shaft, encloses the gearing and mechanism by means of which connection is made with the rapid movement derived from the constant speed shaft *B*.

The Speed and Feed Governing Connection.

The feed shaft at the back of the machine, as may be seen in Fig. 2, drives three separate mechanisms. The first connection, through the spiral gearing shown and a set of worm gearing, is with the short shaft on which is mounted the governing disk, seen also in Fig. 1 and at *U* in Fig. 3. To the periphery of the disk are attached dogs which engage a pin on the end of lever *V* at the front of the machine. This lever is mounted on a rock shaft which extends through the machine and is connected in the rear with levers and a link to the mechanism for operating the speed change clutches in the base of the machine for gears *G* and *H*, as previously described. To the left side of the governing disk, in the position shown in Fig. 3, are attached dogs carrying pins which operate a ratchet mechanism, revolving a cam shaft, by means of which the feed shaft is connected with either the constant speed rapid movement, or the slow speed feeding movement operating from the spindle, as desired. The worm shaft by which this governing disk is driven is extended out to the front of the machine, where it is geared to a short stud *W* with a squared end, by means of which the movements may be manually operated when setting up the machine.

The Cross- and Turret-slide Cams and Connections.

The second member driven from the feed shaft in the rear is the cross-slide cam. This is of the cylindrical type, mounted on a shaft extending through the bed from back to front, and driven by worm gearing from the feed shaft. The circular cover plate for the chamber holding the cam may be plainly seen at the front of the machine, below and just to the right of the cross-slide in Fig. 1. This cover plate is removed for giving access to the cam drum when changing the cross-slide cams for setting up new work. The guiding surfaces of the cam operate a roll, fixed to the under side of a square bar, which extends through the machine, with bearings at the front and rear. This bar has rack teeth cut on its upper side at the rear, meshing with a pinion on a stout rock shaft, which in turn is keyed to a sliding pinion held in the cross-slide base. This latter pinion engages the teeth of a rack fast to the cross-slide. It will thus be seen that the movement derived from the cross-slide cam is transmitted through the square bar to the rock shaft, and thence to the cross-slide—a very direct and powerful connection, which still permits freedom of adjustment for the cross slide base on the bed, to suit the work being operated on. The cross-slide carries two tool-post blocks.

A third function of the feed shaft is the driving of the turret slide cam. This cam (which may be seen through the opening in the rear of the bed in Fig. 2), like that for the cross slide movement, is of the cylindrical type and is enclosed in a cylindrical chamber. It is of cast iron, with an inserted steel working face for that part of the surface where most of the wear comes, during the feeding of the tools. It will be seen that this cam is connected with the feed shaft by spur gearing, instead of by worm gearing as in the case of the cross-slide movement. The turret cam with the four-sided turret used makes four revolutions to one of the cross-slide cam, or for each piece of work completed. To avoid the necessity of a complicated automatic turret clamping mechanism, a supporting arm is provided for the turret stem, which stiffens it so as to adapt it for even the heaviest forming cuts.

It will be seen that ruggedness is a prime characteristic of this machine. The bed is one solid piece of double box section, while the turret slide and head-stock are both low and very firmly gibbed to the stiff bed. The machine is built by Potter & Johnston, Pawtucket, R. I., and, as a large proportion of the work for which their older machines are adapted is in the vicinity of 6 inches in diameter or smaller, this machine should find a large field awaiting it.

GOULD & EBERHARDT STOCKING CUTTER.

During the past decade the development of gear-cutting machinery has been rapid, and the improvements in this class of machine tools has perhaps been more radical than in almost any other class of machines. While the development of the gear-cutting machines themselves is of supreme importance, one must not lose sight of the fact that the actual methods of producing the gear tooth, by means of a rotary cutter, have also presented a field for improvement. To obtain good results, if accurate and noiseless running gearing is the object sought, it is required that a gear tooth should first be roughed out with a roughing out or stocking cutter, before the tooth is finally finished with an ordinary gear tooth cutter of the regular type.

Some five or six years ago, the firm of Gould & Eberhardt, of Newark, N. J., brought out what they term their "stepped style" of stocking cutter, for roughing out the teeth of coarse pitch gearing, previous to the finishing operation with a standard gear tooth cutter. The advantages claimed for these cutters over the ordinary square saw or slotting cutter, which had previously been used most generally, was that by having steps provided in the cutter, the chips were broken up, and

consequently less power was consumed by the operation, and the strain on the machine and parts was not as great. At the same time, the lower step of the cutter removed the wide flare of the gear tooth space between the top of the teeth which the square stocking or slotting cutter did not do, and in this way left a more nearly uniform amount of metal all around the tooth outline to be removed by the finishing cutter.

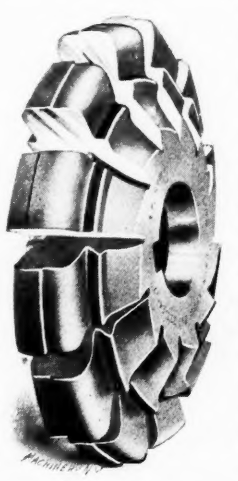


Fig. 1. Gould & Eberhardt Improved Stocking Cutter for Gear Work.

While this idea was not new at the time, it was the first time that cutters of that kind were manufactured for the trade. Since then the firm has still further improved this class of cutter, and has recently brought out and patented a new stepped style of stocking cutter, shown in the accompanying illustration, Fig. 1. The improvement embodied in the new form will be most readily seen by comparing the new and the old style as shown in the accompanying line engraving, Fig. 2, where the new style is shown to the left, and the old style to the right. It will be seen that the new stocking cutter finishes the bottom of the tooth space, thereby relieving the finishing cutter of this duty, and saving the latter where it usually wears out first. It also approaches the finished outline at the top of the tooth more closely than did the old style. The essential feature of improvement, however, is the recessing of the tops of the cutting teeth, as shown most plainly in the halftone illustration, Fig. 1, so that each tooth practically cuts out about half as much as formerly. This permits a maximum amount of stock to be removed with a minimum amount of power consumption, because the cutting edges, being staggered, will be more thoroughly lubricated while cutting. As compared with the ordinary saw stocking cutters, the superiority of the new design needs, of course, no demonstration. The large corners left by saw stocking cutters are entirely removed by the present design, and the cutters can be made considerable wider at the hubs, thus lessening the liability for the keys to shear off; in consequence of all this, faster speeds and feeds are permissible without the strains on the machine itself being increased, but rather lessened.

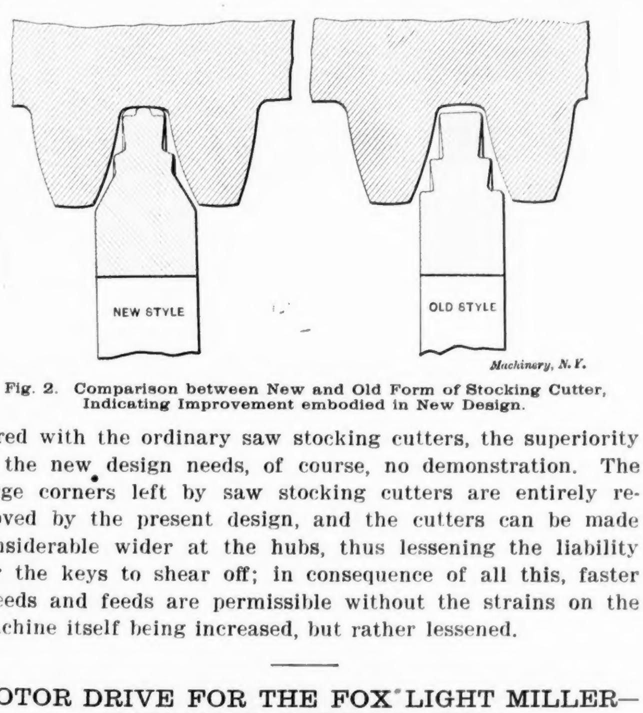


Fig. 2. Comparison between New and Old Form of Stocking Cutter, Indicating Improvement embodied in New Design.

MOTOR DRIVE FOR THE FOX LIGHT MILLER—UNIVERSAL DIVIDING HEAD.

The Fox Machine Co., 815-825 North Front Street, Grand Rapids, Michigan, has been for a number of years building small hand and power milling machines for light manufacturing, having originally become interested in this line from filling the requirements of the Fox Typewriter Co., an allied corporation. The company has recently designed a belt-connected motor drive for its line of small millers which is interesting in the simplicity of its adaptation to machines of standard type, as well as in its effectiveness. The machine to which this drive is applied in Fig. 1 is a No. 3½ hand and power feed milling machine of the builder's standard design, which was furnished to the Charleston navy yard and built to meet the requirements of the government's standard specifications for motor-driven machines.

As shown, the miller is mounted on a supplementary floor base, which is also provided with suitable connections for supporting the motor. The latter, as may be seen, is hinged at the left-hand side to this base, and is supported on the right by the short end of a foot lever, whose outer end is connected with a treadle and a foot-operated catch, by means of which the motor may be raised about its hinge or allowed to fall by gravity, at the will of the operator. A counter-shaft carrying a cone pulley and a driving pulley is supported over the machine by a cast framework, attached to the top of the milling machine column and to the motor base. The driving pulley on this counter-shaft, which has two diameters and is flanged, is belted to the double flanged pulley on the armature shaft. The hinged connection of the motor and the foot lever operated movement provided for it, are employed for starting and stopping the machine. The raising of the motor slackens the belt and thus stops the counter-shaft, while the dropping of it tightens the belt so that the whole power of the motor may be transmitted. It will be noted that the arrangement permits the use of a cemented or "endless' driving belt.

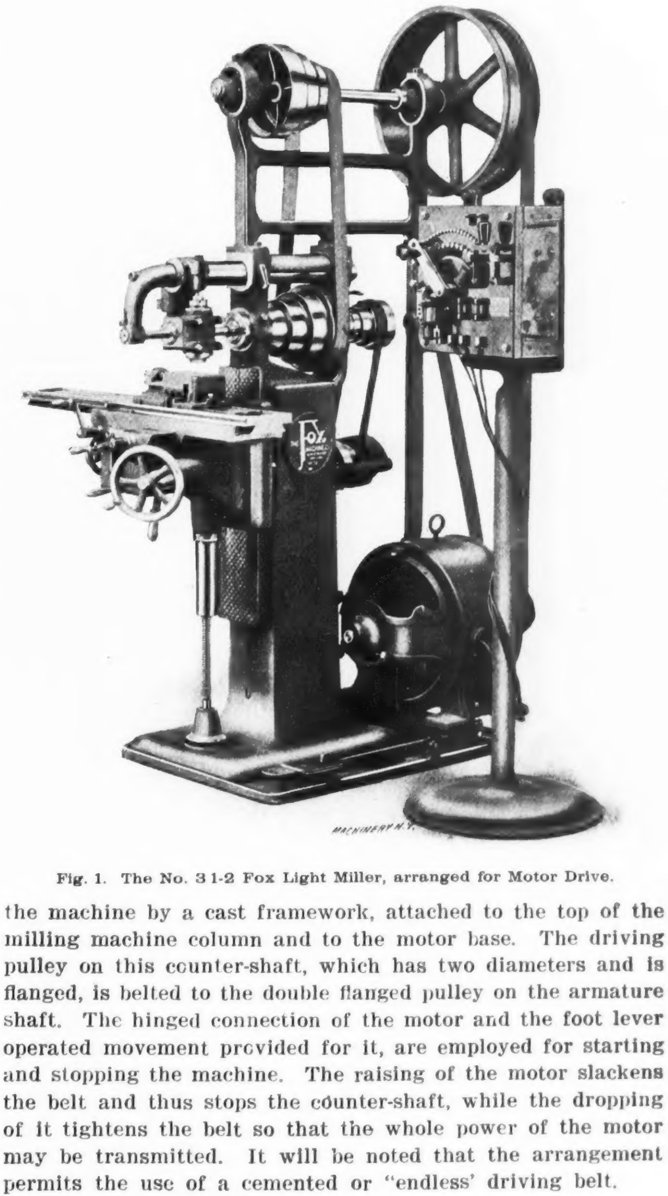


Fig. 1. The No. 3 1-2 Fox Light Miller, arranged for Motor Drive.

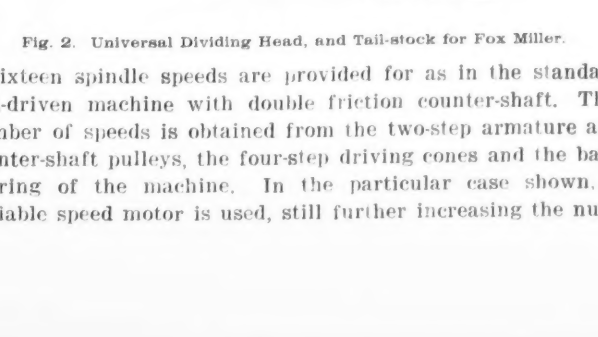


Fig. 2. Universal Dividing Head, and Tail-stock for Fox Miller.

Sixteen spindle speeds are provided for as in the standard belt-driven machine with double friction counter-shaft. This number of speeds is obtained from the two-step armature and counter-shaft pulleys, the four-step driving cones and the back gearing of the machine. In the particular case shown, a variable speed motor is used, still further increasing the num-

ber of speed changes. The starting switches and controller are mounted on a pedestal, as shown, which may be set in any position convenient for the operator.

Among the accessories with which these machines are provided may be mentioned the vertical milling attachment shown in place on the machine, and the dividing head shown in Fig. 2. The former is provided with an angular adjustment which may be swiveled through an arc of 90 degrees from the vertical to the horizontal. By reversing it, it will cover this range in the other direction, giving a full movement of 180 degrees. It may be adjusted transversely of the spindle as well from any convenient distance from the base of the column.

The universal dividing head- and tail-stock shown in Fig. 2 are new and are especially designed for the No. 3½ miller, though they may be used on other sizes of the builder's machine for small work. The spindle is held in a long taper bearing and may be securely locked by the knurled thumbscrew shown at the top. The spindle may be elevated to any angle from the horizontal up to the vertical, and when in the latter position is especially stable, the height of the work above the table being reduced to a minimum. The tail center may be raised or lowered or tilted for taper work. The index plates furnished are drilled on a special automatic machine having a master worm gear 18 inches in diameter, thus insuring great accuracy. They give all divisions from 2 to 50, and the principal divisions up to 360. The device will be found useful for cutting small gears, milling squares, hexagons, etc., fluting taps and reamers, and doing a large variety of other work of this class.

BARNES SLIDING EXTENSION GAP LATHE.

The Barnes Drill Co., Inc., 602 South Main St., Rockford, Ill., is building the extension gap lathe shown in the two accompanying half-tones. The advantages of this form of gap lathe

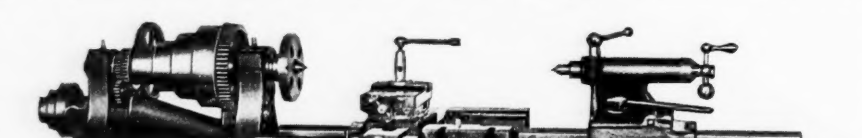


Fig. 1. The Barnes Sliding Extension Gap Lathe.

are well-known and indisputable. Essentially, the idea consists of mounting the bed of the lathe on a base on which it may be adjusted longitudinally close up against the head-stock, or as far away from it as may be necessary to suit the width of any work of such diameter as to require the use of the gap. Fig. 1 shows the lathe with the gap closed for ordinary work, while Fig. 2 shows it extended, with the large swing face-plate in use. This design has an advantage over the lathe of fixed gap in that the width of the opening between the shears and head-stock may be made as little or as much as is required to swing the work, thus making it possible to bring the carriage and tool close up to the surface being turned. It obviates the necessity also for a filling-in piece, such as is sometimes used for extending the ways across the gap to

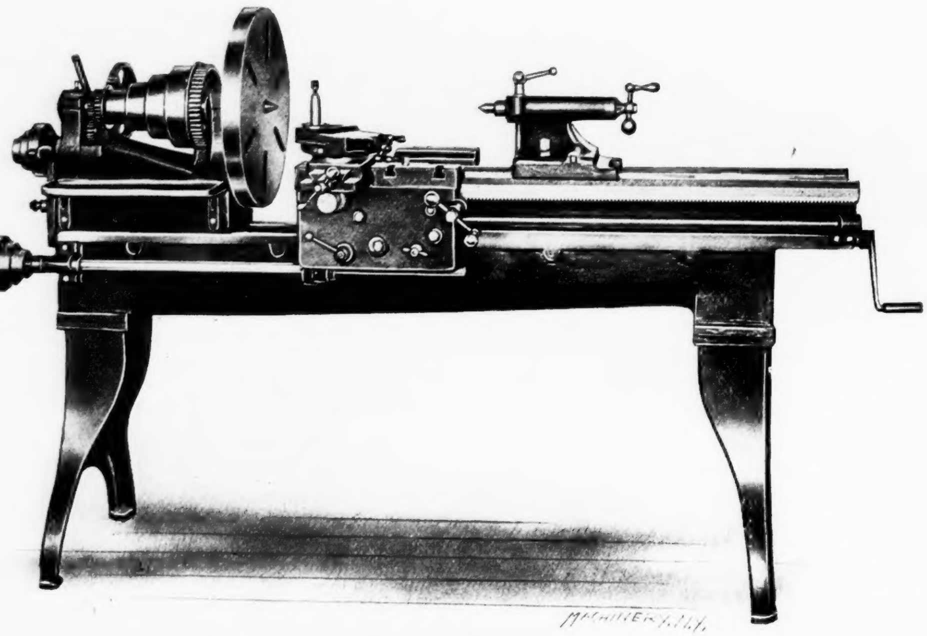


Fig. 2. Lathe with Supplementary Bed shifted, opening Gap for Full Swing.

support the carriage on ordinary work, for cuts close to the live center.

The upper bed is adjusted on the base by means of a screw operated by a crank, shown at the rear end. The two beds are fitted together by dove-tail construction which permits them to be firmly clamped together at any adjustment by means of clamp bolts passing transversely through the main bed. The carriage has the cross-slide bridge located to the left, so as to bring the tool close to the work. For large diameter cuts, the cross-slide ways are extended in front to make provision for facing up to the full diameter without overhanging the tool or the tool-holder. Power cross feed and a compound rest are provided. The carriage is fitted to the bed with a V-bearing in front and a flat bearing at the rear. It is gibbed at the rear and may be clamped for cross-slide work. It is also fitted with T-slots for holding work for boring, etc.

The lathe is arranged for screw cutting as well as for turning. The splined feed-screw is carried well up under the ways, as in the lathes of standard construction, but is connected by gearing to a splined driving shaft, which is carried down below the gap so as not to interfere with work of the full diameter. The three-step cone pulleys may be used for the feeds, or they may be removed and the connections made with change gears for positive turning feeds or screw cutting.

The head-stock gearing gives the necessary power for turning full diameter of the gap. The head-stock casting is heavy and strong. The spindle is hollow, made from a good grade of steel, accurately ground and running in bronze bearings, carefully scraped and fitted. The cone pulley has four steps and is back geared, giving eight changes of speed in all. A push pin connection is used for locking the gear with the cone, so that a wrench is not required when throwing the back gears in or out.

The lathe is furnished with a friction counter-shaft, change gears, center rest, large and small face-plates, and the necessary wrenches. The swing over the carriage is 8½ inches; over the bed, 13 inches; and over the gap, 22½ inches. A

lathe with a 5½-foot bed takes 36 inches between the centers when used as an ordinary lathe, and 54 inches when extended; the gap opens 18 inches wide. It will be seen that the extension feature of the bed is useful in increasing the distance between centers, as well as in giving greater swing. The arrangement is such that when used as a simple lathe it has all the conveniences expected in machines of its type, the gap feature being obtained without any sacrifice of utility of ordinary work. The machine should be especially useful for garages and repair shops.

A REMARKABLE BROACHING MACHINE AND ITS WORK.

We show in the accompanying half-tones a Lapointe broaching machine provided with special cutting tools, and engaged on what is, without much doubt, the heaviest broaching operation ever undertaken. The size of the hole to be broached is approximately 8 inches square, though the hole is not really square, being of the special shape shown in Fig. 2. Not only is the work remarkable on account of its size, but also in the fact that the surfaces had to be broached on a taper, the outer end of the hole being ½ inch further across than at the bottom, while the work is rendered still more difficult from the fact that the opening is closed at the small end. Thus the only way of broaching is to commence at the bottom and work outward. A recess 3 inches long and about

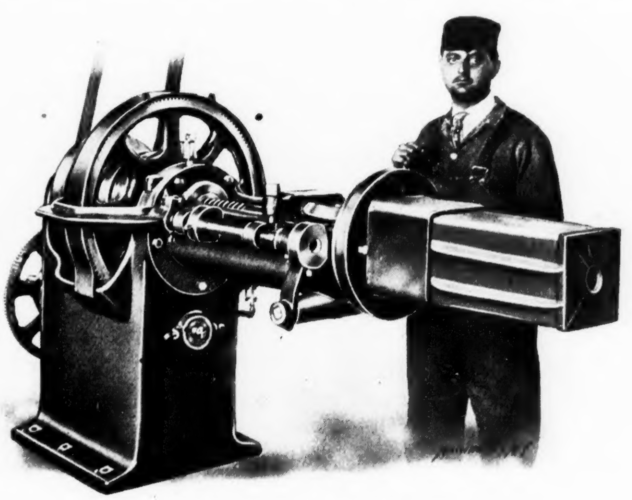


Fig. 1. The Machine with the Work in Place.

¼ inch deep is furnished at the bottom, however, to allow the starting of the broach. The stock to be removed on each of the finished surfaces of the work is about 1/16 inch thick; the total area to be broached is 14 inches long, with a developed width of 24 inches. In the center of each face of the hole, it will be noticed that there is a half-round recess; no broaching is done in this part. This piece of work is a steel casting.

The machine used is the largest of the line of broaching machines made by the builder, the Lapointe Machine Tool Co., of Hudson, Mass. The construction of these machines has been previously described. (See New Machinery and Tools, in the July, 1907, and May, 1908, issues of MACHINERY.) The mechanism consists primarily of a threaded draw bar or ram, operated by a revolving nut, driven by suitable gearing and reversing mechanism, this mechanism being operated by dogs and adjustable stops to give the required length of operating and return strokes. Practically the only special feature of the equipment is the special broaching head and broaches used. These are of such unusual size and ingenious construction as to be of decided interest.

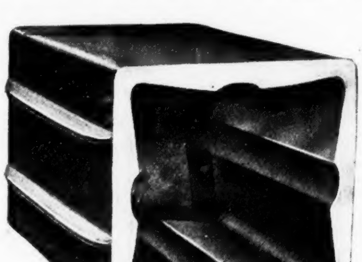


Fig. 2. The Hole which is to be Broached.

The construction of the broaching head is perhaps most plainly shown in Fig. 3. It consists essentially of a central square mandrel, tapered to the taper of the hole to be finished in the work, and provided with ways in which slide four separate broaches, one for each corner of the work. These broaches are connected with the head of the ram of the

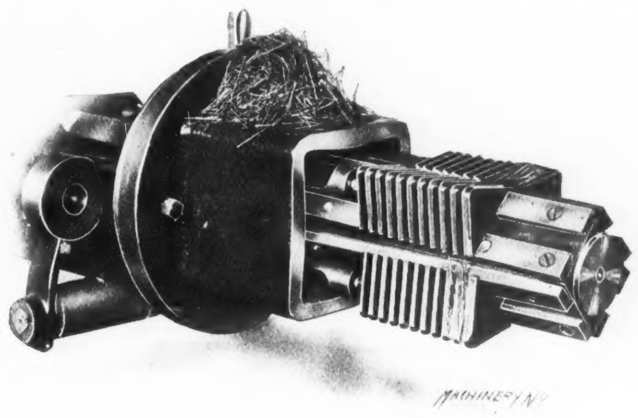


Fig. 3. The Taper Broach and the Chips it produces; note the Flexible Pulling Rods.

machine by bars, which are milled down to such a thinness as to have sufficient flexibility to permit the broaches to spread apart as they approach the inner end of the stroke, and come together again as they return to the starting position on the outer end of the mandrel. Each of the broaches is made of a solid piece of tool steel, with a series of 13 teeth of suitable shape milled in it.

In operation the ram is first extended to the outer limit of its stroke, with the broaches at the outer and smaller end of the square central mandrel. The work is then placed over the mandrel as shown in Fig. 1, in which position the broaches nearly touch the closed bottom of the hole. The outer teeth in this position are in the recess. The machine is then started up, and the revolving nut, and threaded ram pull the broaches up on the tapered guides of the square mandrel, by means of the flexible pulling rods. As the broaches are thus drawn inward on a gradually expanding form, they cut the required shape in the interior of the steel casting. The broaches first are tapered, so that the outer end is 1/32 inch larger than the end to which the pulling rods are connected, this being the amount which is to be removed from the work in each operation.

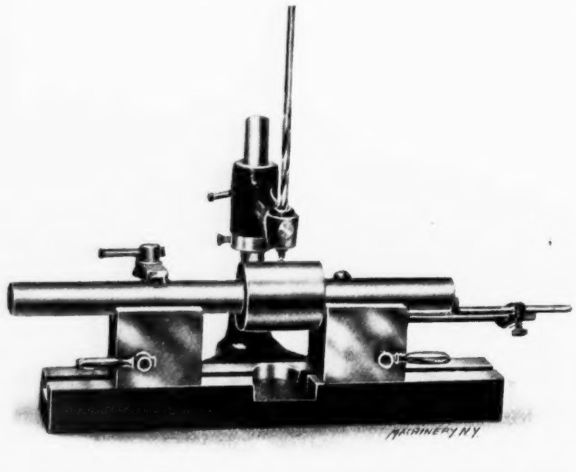
As is shown in the engraving, a special abutment or base is provided for taking the thrust of the work as it resists the action of the cutters. Piled up on this special base, in Fig. 3, will be seen the chips produced at one stroke of the machine. It will be noted from their character that a cutting action of the most desirable kind is effected by the broaching blades, indicating that the work is done in a very superior way. The approximate pulling strain on the four rods operating the broaches is estimated by the builders to be from 75 to 100 tons.

ADJUSTABLE DRILL JIG.

The Cleveland Specialty and Mfg. Co., 3001 Searsdale Avenue S. W., Cleveland, Ohio, has brought out an interesting adjustable drill jig, as illustrated in the accompanying half-tone. This jig is intended to eliminate the laying out of certain classes of work for drilling, and is intended particularly for circular pieces of work which can be placed in the V-blocks shown. It is, of course, especially valuable when drilling duplicate pieces of this character. A great deal of time is spent in laying out simple work for drilling, hunting for V-blocks and clamping devices, and placing the work on the drill press; and, finally, when the piece is drilled, it is often found that the hole has not been correctly located, on account of defective lay-out or setting up, or because the drill has run out.

Difficulties of this kind will be eliminated by the use of this adjustable jig. The design is very simple. The base of the device is finished at the bottom, where it rests on the drill press table, and on the top, where two V-blocks slide back and forth. The blocks are provided with dove-tails to fit a corre-

sponding dove-tail slot in the base. The levers shown at the front of the V-blocks serve the purpose of clamping them in place wherever desired. A clamping device for fastening the work in the V-groove is provided, as indicated in the engraving, and at the right-hand end an adjustable stop is arranged for. This can be extended out to any length required for long pieces, or pushed in close to the V-block for short pieces. The stop and the clamp may be used on either block, and when



Cleveland Specialty Co.'s Adjustable Drill Jig for Cylindrical Work.

short pieces are being drilled, one V-block only may be employed. In the middle of the base-block at the back of the device is a boss which supports a steel stem on which the arm holding the drill guide bushing is mounted. This arm can be adjusted up and down on the stem to suit the work, and it can also be swung to one side if it is required that a larger drill or reamer should follow the first drill, so the drill bushing does not have to be removed for this purpose.

As a great deal of the drilling work in most machine shops consists of drilling and reaming pin-holes in shafts, holes to be tapped for set-screws in collars or levers, spotting of shafts for set-screws, etc., and, as it is seldom considered profitable to build special jigs for these purposes, a universal appliance like the one shown, will undoubtedly prove of value in nearly every machine shop where there is a premium placed on the accuracy and rapidity of the operations performed.

KELLY ADJUSTABLE REAMERS.

The accompanying half-tone illustration and line engraving show the appearance and application of a new type of reamer and boring tool, placed on the market by the Kelly Tool Co., Cleveland, Ohio. As will be seen from the half-tone, which shows a front view of the tool, it consists of a rectangular holder into which are inserted two cutters, one on each side of the holder, and inclined at an angle of 45 degrees. These

Fig. 1. The Kelly Adjustable Reamer and Boring Tool.

cutters constitute the cutting edges of the reamer, and are adjustable, so that each size of reamer covers a range of ¼ inch, the reamers being made in seventeen sizes, from 1 inch up to 5¼ inches. The tool may be used as a boring tool, as well as a reamer, the cutters being held absolutely rigid in position by the binding screws, the head of one of which is shown near the right-hand edge in the half-tone illustration. The reamer holder, as shown in Fig. 1, is in turn held in a bar, as indicated in Figs. 2, 3 and 4. In Fig. 2 is shown a bar used either for "floating" or rigid work, a pointed screw being used to hold the holder in place when it is not desired to have it floating. Fig. 3 shows the arrangement used when the tool is used for work where it is required that the cutters finish a hole clear down to the bottom. It will be seen that the holder is held by a plate on the end of the bar, fastened in place by four screws, and also by a screw passing through the tapered hole on its center line. Finally, in Fig. 4, the tool is shown placed in a boring-bar, and used as a double boring cutter, permitting the use of the front end of the bar as a guide or pilot.

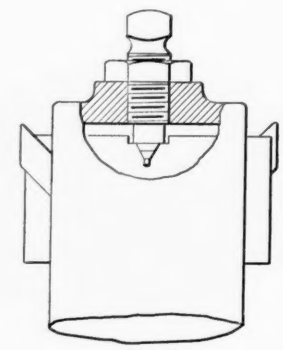


Fig. 2

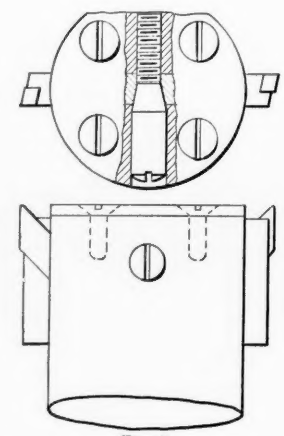


Fig. 3

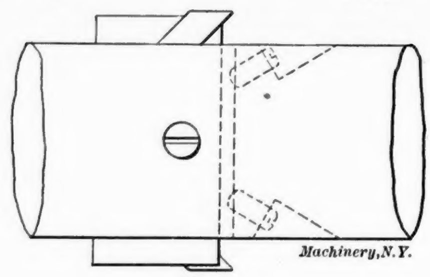


Fig. 4

Figs. 2, 3, and 4. Different Applications of the Kelly Adjustable Reamer.

The simple construction of this tool, including the adjustable features, the comparatively small number of tools necessary for the complete set, the ease of setting and adjustment, all tend to make it valuable in machine tool work, and its application to any kind of turret machine, lathe, boring mill or drill press, makes it as universal a tool as can well be conceived of.

LUCAS HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

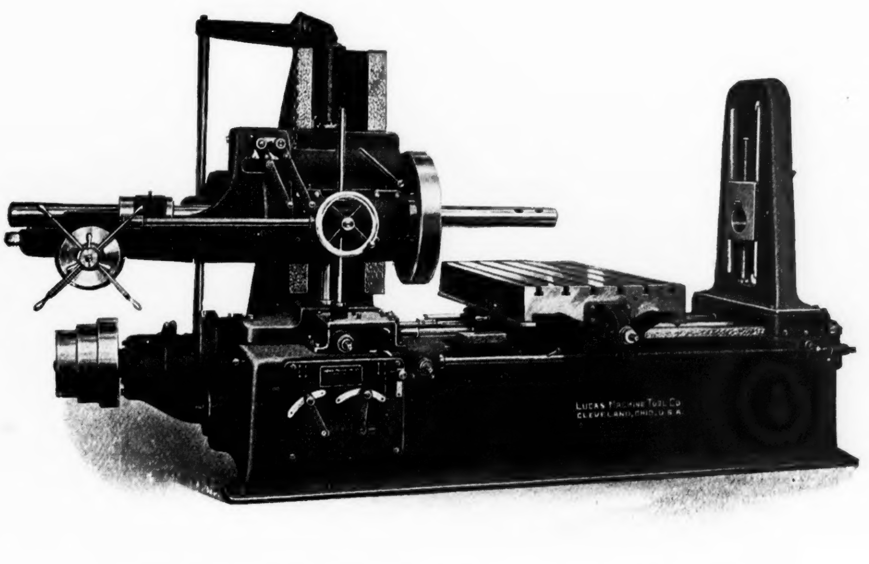
The machine illustrated in the accompanying half-tone is quite extensively used in railway shops on account of its adaptability to a wide range of work. Special attention has been given in the design and construction of this machine to the production of a high-grade manufacturing machine, equally useful for tool-room work requiring great accuracy and for general manufacturing where power and rigidity are the principal essentials. A good example of the work which is being done on it in railroad shops is a tumbling shaft in which the holes may be bored, and the hubs faced parallel and true with the holes by milling, at one setting; also, air pump cylinders, which may be bored, and both ends faced by milling, at one setting.

The principal feature of this machine is the raising and lowering of the spindle head, which is a constant weight, instead of raising and lowering the platen with its load, which is widely variable. This construction allows the use of a deep box bed of great stiffness, which gives a solid foundation to the other members of the machine, and keeps them in accurate relation to each other in all positions and eliminates the necessity of building a foundation under the machine. As a foundation is not necessary, the location of the machine is not confined to the ground floor.

The advantages offered by this machine are, in short, that work can be bored, drilled, and milled at one setting, and all the work done accurately without any measuring, trying or

"papering up," all of which the precision screws and the graduated dials make unnecessary. Further, this construction allows the addition to the machine of a vertical power feed for milling purposes, which is a most valuable feature for many classes of work.

The spindle is made of un-annealed hammered crucible steel, and is accurately ground its entire length, and has a long bearing in the sleeve. It is forged and rough turned at least six months before it is finished, and is allowed to season between every operation. The front of the driving gear forms a face-plate to which the facing head or face milling cutters or other large tools may be attached.



Lucas No. 3 Precision, Horizontal Boring, Drilling, and Milling Machine.

Milling feeds to platen and head (which includes the outer support for the boring-bar) make the machine universal and capable of finishing at one setting many kinds of pieces which would otherwise require resetting and finishing in other machines, and the addition of a graduated revolving table allows holes to be bored and drilled and surfaces to be milled at various angles. A power cross-feed is provided for the platen to make the machine complete for milling purposes. This greatly increases the usefulness of the machine and makes it easy to do many jobs which would otherwise be difficult. It may be mentioned that the length of the cross-feed to the platen is sufficient so that one job of boring may be made ready on one end of it while the machine is boring another piece on the other end.

The yoke is adjusted along the bed with a wrench, and as there is a geared connection between the two screws that respectively adjust the spindle head and the outer support for boring-bar, which is in the yoke, the outer support is kept in automatic alignment with the spindle, and cannot be thrown out by chips getting under the yoke, because it is fitted to the bed. The yoke may be altogether removed and then put back in its original position without destroying the alignment of the outer support for the boring-bar with the spindle, which is a valuable feature where it is required to do work on pieces which are longer than the nominal capacity of the machine. The outer support for the boring-bar is bored out after the machine is assembled, which insures its perfect alignment with the spindle.

The driving gears in the speed box are made of steel and are controlled by two levers on top, giving nine changes of speed. The two levers on the head of the machine, which are interlocking, multiply these speeds by two, giving a total of 18 changes of speed in geometrical progression. At each spindle speed, only such gears are in mesh as are used to obtain that speed, and there is therefore no friction loss due to the revolving of idle gears. The driving pulley runs on a stationary bushing. The main driving clutch is operated by a lever at the front end of the machine, within easy reach of the operator, and when the machine is stopped, only the driving pulley continues in motion. A direct connected motor drive can be applied if desired.

The feed motion is taken from one of the driving shafts which runs at a higher speed than the spindle. This makes it possible to obtain coarse feeds without gearing up, thus avoiding excessive strain on the feed gears and bearings. The fine feeds are obtained by reduction gearing. Another point of advantage of the arrangement is that it gives two series of feeds, a coarse series with the back gears in and a fine series with the back gears out. This gives a greater total range of feeds without excessive increments. There are 18 variations of feed, 9 for either position of the spindle back gears from 0.005 inch to 0.537 inch per revolution of spindle. The rate of feed is the same for every part to which it is applied.

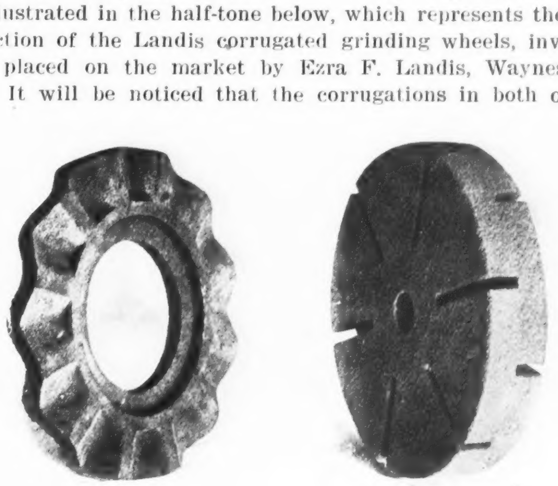
The adjustments of the spindle head, the outer support for the boring-bar and the platen are made by precision screws. The screws are provided with dials graduated to read thousandths of an inch, thus allowing holes to be bored or drilled, and surfaces to be milled an exact distance apart, making it possible to produce interchangeable work without the use of jigs, or jigs may be originated on the machine more quickly and accurately than by any other method. The platen is of extra size and thickness and has six finished T-slots. It will be noticed that it is especially deep, the aim being to make it so stiff that with ordinary care, there will be no appreciable springing when work is clamped upon it.

The machine is regularly supplied with automatic feed to the spindle, automatic cross-feed to the platen and vertical feed to the head. The head and outer support for the boring-bar may be quickly moved by power, and may also be moved by hand from both the front and end of the machine.

This machine is at present the largest of the various sizes made and sold by the Lucas Machine Tool Co., Cleveland, O., and has a spindle 4 inches in diameter with 60 inches total traverse; the greatest distance between the face-plate and outer support for the boring-bar is 6 feet; the greatest distance from the top of the platen to the center of the spindle is 26 inches; and the platen, which is 30 inches wide and 48 inches long, has a cross-feed of 36 inches.

THE LANDIS CORRUGATED GRINDING WHEELS.

An interesting departure in the making of grinding wheels is illustrated in the half-tone below, which represents the construction of the Landis corrugated grinding wheels, invented and placed on the market by Ezra F. Landis, Waynesboro, Pa. It will be noticed that the corrugations in both of the two styles of wheels shown extend from the sides of the wheel to the center, and leave no continuous or unbroken cutting surface on the periphery of the wheel. This construction insures a much greater positive cutting action of the wheel, the principle of cutting being similar to that of a milling cutter. Comparative tests, undertaken with two 8-inch carborundum wheels, one of the ordinary plain



Corrugated Grinding Wheels for Rapid Grinding.

type, and the other of the corrugated type illustrated, on a plain grinder, using a lever with a weight to press the work against the wheel, indicated that with this construction of wheel it is possible to cut nearly four times as much as with a plain wheel, both wheels being of the same grit and grain. The increased wear on the corrugated wheel was only 25 per cent, in spite of the increased efficiency, and this amount of wear can be reduced by using a much harder wheel when corrugated. The advantages claimed for this construction, however, are not only that it will increase the cutting capacity, but that a wheel made on the corrugated principle will cut all kinds of stock, aluminum, hard and soft steel, wrought or malleable iron, bronze, brass, copper, hard rubber, wood fiber, leather, bone, ivory, marble, granite, and in fact anything grindable, with a great deal less liability to glazing of the wheel. These wheels are made either of carborundum, emery or corundum, and by either the vitrified or silicate process.

CLIMAX CHAIN BLOCKS.

The Climax Hoist Co., 1753-55 North Howard Street, Philadelphia, Pa., has designed and constructed a line of hand-operated chain hoists which are believed by their builders to combine a great number of points of excellence. The purpose of the designer (an engineer of long experience in hoist and crane work) has been to produce a high degree of efficiency, simplicity and durability, with a low manufacturing cost, in such a way as to give great value for comparatively little money.

The exterior of the hoist is shown in Fig. 1, while the construction may be followed from the line engraving, Fig. 2. Its simplicity will be at once appreciated. The hand-wheel *A* is threaded to the hub of the friction plate *B*, the latter being fast to the driving shaft *C*. To the other end of *C* is fastened the driving pinion *D*, which meshes with the internal gear *E*, mounted on a stationary stud supported by the cover *F*. The

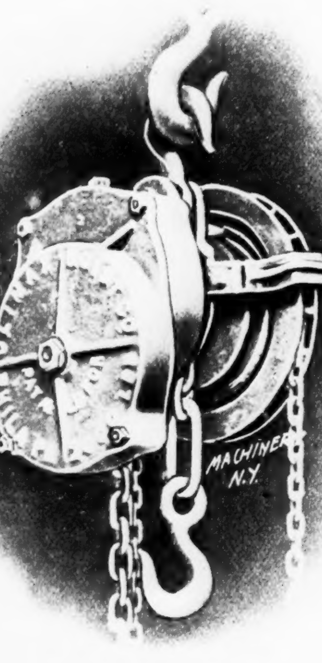


Fig. 1. The Climax Hoist.

teeth of the pinion formed on the hub of *E* engage the internal teeth of the load gear *G*, on whose extended hub is keyed the load chain sprocket *H*. The long hub on *G* is supported by roller bearings at *J* and *J* in the main frame *K*; this hub also serves as the bearing for driving shaft *C*. Gears *G* and *E* run submerged in oil in casing *F*.

It was stated that sprocket wheel *A* was threaded to the hub of friction plate *B*. This is required by the automatic brake mechanism, which is provided to keep the hoist from running backwards under a heavy load when the workman releases the hand chain *L*. In lifting work by the hand chain, the sprocket wheel is turned in a clock-wise direction, as indicated in the sectional view, Fig. 2. In doing this it is screwed inward on the hub of *B* until it clamps between the flange on *B* and its own web, friction washers *O* and ratchet plate *P*, thus making *A*, *O*, *P*, *O*, and *B* revolve as a solid unit, raising the work through the medium of the gearing previously described. If the hand chain is released, the load tends to revolve shaft *C* and friction plate *B* backwards. This, however, is prevented by the ratchet teeth on *P* which engage with the pawl *Q*, which is fast to the casing of the hoist. By this means the rotation of *C* is prevented and the work remains safely suspended.

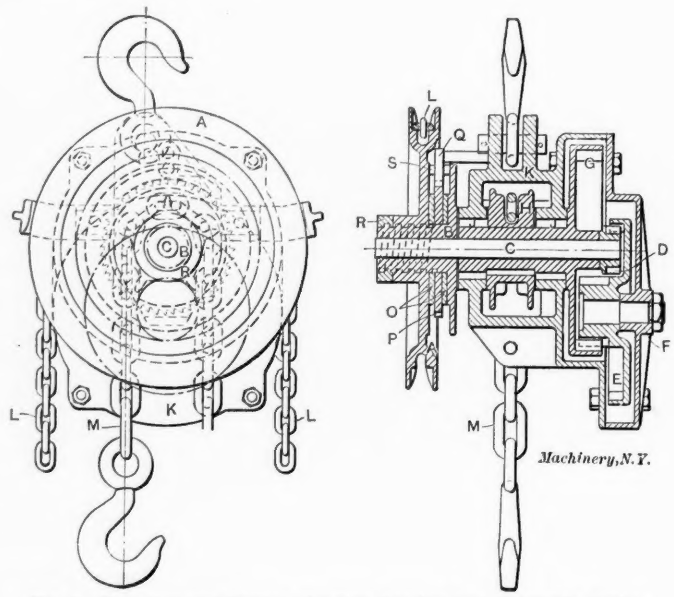


Fig. 2. Elevation and Section showing Gearing and Automatic Brake.

When the operator desires to lower the load, the left-hand side of the chain *L* in Fig. 2 is pulled, revolving the sprocket in a counter clock-wise direction. This unscrews sprocket *A* on the hub of *B* from contact with friction washers *O* and ratchet *P*, leaving *B* and drive shaft *C* free to be revolved by the load, which is thus allowed to descend. If the load has been removed so that there is not enough weight to cause the mechanism to run back by its own weight, the continued pulling of the left-hand chain screws the sprocket wheel against collar *R* on the hub of *B*, which is thus positively revolved in the proper direction to lower the hook.

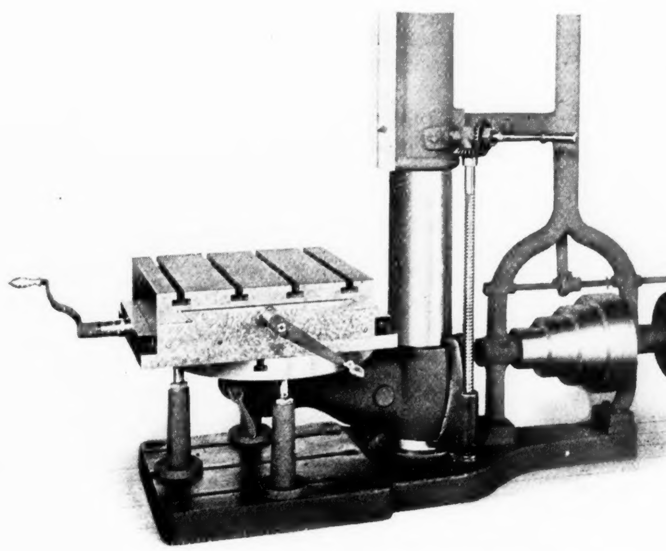
On the other hand, if the workman has been lowering the load, as previously described, and he removes his hand from the chain, the mechanism is positively braked as follows: The turning of the hand-wheel by the operator in a clock-wise direction having ceased, this latter is quickly brought to a stop by the action of friction plug *S* in pawl *Q*. This friction plug serves the double purpose of arresting the movement of sprocket-wheel *A*, and of keeping the pawl in contact with ratchet plate *P* when required. The plug is forced against the web of *A* and the flange on *B* by a spring in its interior. Wheel *A* thus being arrested and the motion of *B* continuing under the weight of the descending load, *A* is immediately screwed inward on the threaded hub of *B*, clamping friction washers *O* and plate *P*, thus arresting the movement of all of these parts against pawl *Q*. When the wheel is being revolved in the opposite direction friction plug *S* raises pawl *Q* so that there is no disagreeable clicking sound, as would be the case if it were held in contact with the ratchet by a spring. As soon as the wheel starts to revolve in the other direction, however, this same plug brings it quickly into contact with the ratchet.

The points of superiority claimed for this design of hoist are—low cost, due to the few parts and simple construction; high efficiency, also resulting from the simple construction, from the use of roller bearings for supporting the load, and from the fact that the gears are enclosed and run in oil; and durability. The parts are all interchangeable so that superior construction is attained at low cost, and repairs are easily effected.

This hoist is arranged with different load chain connections, in seven sizes, to lift from 1,000 to 10,000 pounds.

COMPOUND TABLE FOR UPRIGHT DRILL PRESS.

The illustration shows a compound table for upright drilling machines made by the Mechanics Machine Co., Wyman and Mill Sts., Rockford, Ill. It can be applied to the machines built by this company or to any other drill press. The table is of the European type generally used abroad, being made with two slides at right angles. Combinations of the two movements bring any part of the work directly beneath the drill spindle. The top of the table is provided with four T-slots for bolting down work. The dimensions are 18 x 20 inches, and the



The Mechanics Machine Co.'s Compound Drill Press Table.

sliding movements are 13 and 16 inches. A compound table is a useful adjunct to the drilling machine for work other than drilling, it being practicable with it to use a well-built machine for a variety of milling and profiling operations.

KEARNEY & TRECKER THREE-SPINDLE ATTACHMENT FOR MILLING SPIRAL GEARS.

The arrangement shown in the accompanying half-tone and line engraving was built by the Kearney & Trecker Co., of Milwaukee, Wis., for a manufacturer of cream separators, to be used in cutting the halves of the herringbone pinions which form a part of the drive for the separator bowl. Since these were to be made in great quantities, it was considered worth while to plan out quite carefully the problem of manufacturing them as cheaply as possible. The very satisfactory result of this planning will be appreciated from a study of the device as built.

The arrangement consists essentially of an adjustable attachment fastened to the face of the column for supporting and driving a long spindle carrying three cutters; and of corresponding means for indexing and supporting three work arbors, holding as many gangs of pinion blanks. The cutter arbor, which is in reality an auxiliary spindle, has bronze bearings adjustable for wear. It is carried in a frame, which supports it at right angles to the main spindle, and is connected by spur gearing at the upper end with the short secondary shaft, which is, in turn, connected with the main spindle though a pair of bevel gears. The spur gearing runs in an enclosed box, submerged in oil, the same oil being used to lubricate the bearings. This drive permits the spindle of the attachment to be set to any angle, so that it is unnecessary to swivel the table, as is the practice when cutting the spirals in a universal milling machine. The machine used in this case is one of the builders' No. 2A manufacturing milling machines, which is not furnished with table swivelling adjustment. Of the three cutters carried by the spindle, two are supported between the main and outer bearings, and the third on the overhanging end of the arbor. In these positions they are centered with the three work arbors provided.

The dividing head is provided with means for rotating the work for the spiral cutting, and for indexing for the number of teeth, all three work arbors being connected and operated simultaneously for these movements. The construction of the head will be best understood from the line drawing, Fig. 2. The feed-screw *A* of the milling machine table is connected with the worm-shaft *B* of the head, through simple change gearing. This is done to avoid complication as much as possible. It is often possible to use simple in the place of compound gearing for obtaining spirals of given lead, if the calculations are carefully made. Idlers between the table feed-screw *A* and worm-shaft *B* are used for changing from right-hand to left-hand spiral, or *vice versa*.

The connection between the last gear, *C*, of the change gear train and the worm-shaft *B*, as shown, is effected through the index plate *D*, and the index crank and pin *P*. The plate provided has as many holes as there are to be teeth in the gear, being specially made in this way so as to avoid all possibility of error in dividing.

Worm-shaft *B* and the worm formed on it drive worm-wheel *E*, which is keyed to a short shaft, on the outer end of which is fastened bevel gear *F*. This bevel gear meshes with two others, *G* and *H*, the former keyed to the central spindle *J*, and the latter revolving loosely upon it, but pinned to the hub of spur pinion *K*. *K* meshes with pinions L_1 and L_2, keyed respectively to spindles J_1 and J_2. It will thus be seen that spindle *J*, driven by bevel gear *G*, rotates in the same direction as spindle J_1 and J_2, driven by bevel gear *H* and spur gears *K*, L_1 and L_2.

The whole mechanism of the head is enclosed, and is provided with means for thorough lubrication. The spindles have the same provision for holding and forcing out the taper shanks of the work arbors as are used in the regular milling machines. It will be seen that great care is necessary in the construction of the gearing in the head-stock to prevent back lash in the small bevel and spur gears. The accurate results which have been obtained in the practical use of the device are an evidence of the good workmanship which was put into the construction of these parts.

At the tail-stock end an angle plate is used, clamped to the top of the table and provided with suitable holes for holding tail-stock centers of ordinary construction. These holders are provided with studs which pass through holes in the knee and are clamped by nuts on the other side. The tail-center for

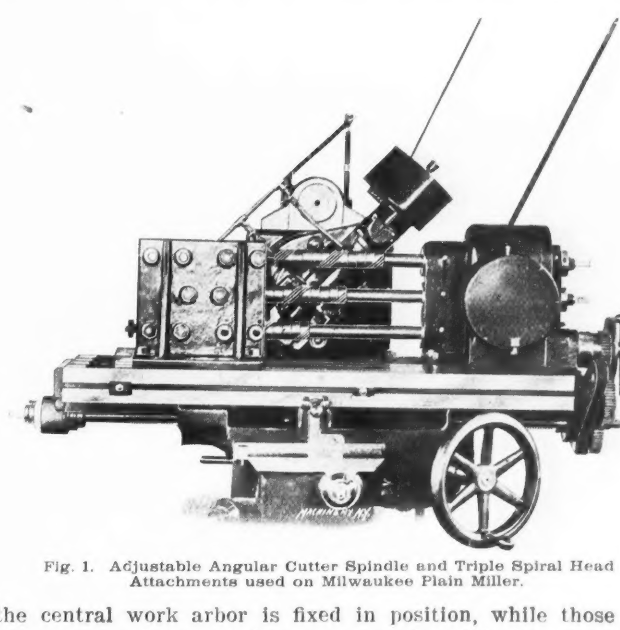


Fig. 1. Adjustable Angular Cutter Spindle and Triple Spiral Head Attachments used on Milwaukee Plain Miller.

the central work arbor is fixed in position, while those for the upper and lower tail-centers may be shifted to positions to accommodate the different lengths of work arbors. In the case shown, the upper work arbor is short and the lower one long, necessitating corresponding positions of the centers. The three arbors are made of these different lengths to provide for the setting of the spindle on the angle. When so set, with the arbor arranged as shown, it will be seen that all three cutters start their work at once and finish at the same time on the three stacks of pinions, each of which is of the

same length. For cutting right-hand pinions with the spindle head reversed to the same angle on the other side, the upper and lower work arbors are interchanged in the spindles in the dividing head, requiring the upper dead center to be moved outward and the lower one inward to correspond.

Cutting oil is supplied to each of the cutters by a system of piping, leading from the regular oil supply equipment of the Milwaukee miller. The final arrangement was somewhat different from that shown, permitting the head to be swung over to the other angle for cutting right-hand gears, without necessitating disconnecting the piping.

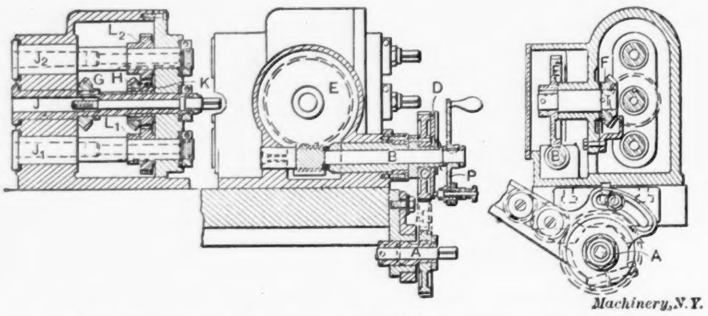
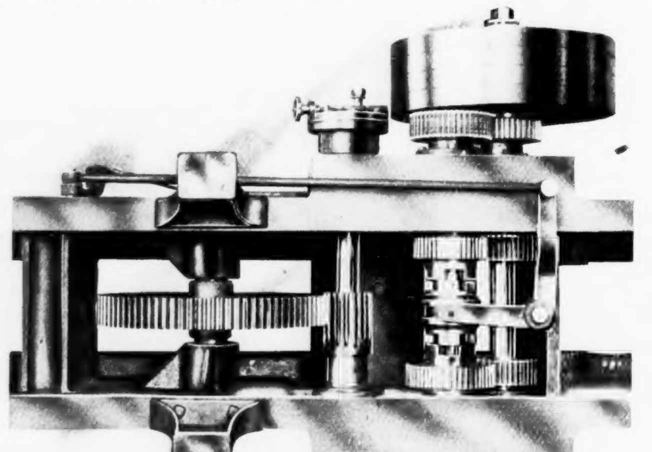


Fig. 2. Elevation and Sections of Triple Spiral Cutting Attachment.

It is interesting to note that the manufacturers for whom this device was furnished have gear hobbing machines in this device was furnished have gear-hobbing machines in being their experience that more accurate work is possible with this method than in the hobbing process. The gear is run at such high speed that defects soon show themselves. No figures are given as to the comparative cost of the two methods of cutting gears.

VARIABLE SPEED DRIVE FOR THE WOODWARD & POWELL PLANER.

The accompanying illustration shows an underneath or a "worm's eye" view of the arrangement of a new two-speed driving mechanism, which has been applied by the Woodward & Powell Planer Co., Worcester, Mass., to its planers. The device is particularly interesting from the simplicity with which it provides two cutting speeds, instantly obtainable, leaving the return speed constant.

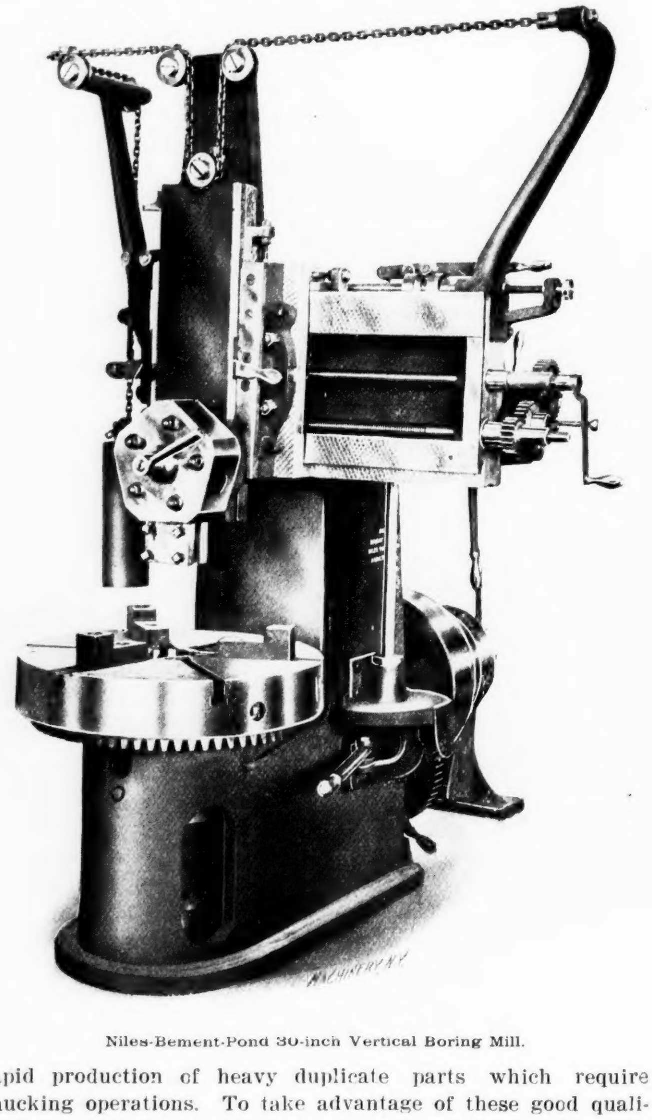

View, from Underneath, of a Planer Drive which gives Two Forward Speeds with Constant Reverse.

The tight and loose pulleys for the return speed are mounted on the driving shaft as usual. The tight pulley for the forward speed runs loosely on the driving shaft, and has a long hub on which the loose pulley for the same belt freely revolves, and to which is keyed a driving pinion, meshing with a raw-hide gear on an intermediate shaft. This intermediate shaft has keyed to it, inside the frame of the planer, a double-ended jaw clutch, adapted to engage corresponding jaws in the hubs of two gears of different diameters, which are loosely mounted on it. These gears engage, in turn, raw-hide mating gears, fast to the driving shaft. The double-jawed clutch is connected by a horizontal bent lever and a reach rod to a vertical shifting lever at the side of the machine, within convenient reach of the operator. The two loose clutch gears on the intermediate shaft are self-oiling and together with the clutch, are of massive construction, and so designed that there is no danger of the teeth slipping out of engagement, except when forced out by the lever.

The arrangement is simple and easily understood. When driving forward, the power is transmitted to the pinion on the hub of the driving pulley, thence to the raw-hide gear, driving the intermediate shaft, and from there to that one of the two gears in the bed which is engaged by the clutch to the intermediate shaft. From that gear the power is transmitted through the driving shaft, and thence through the usual gearing to the table. On the return stroke, the belt drives a pulley fast to the driving shaft, which operates the planer table in the ordinary way, at the same time driving freely the intermediate shaft, which is connected through the gearing with the other driving pulley. The ordinary variation obtained is in the ratio of $1\frac{1}{2}$ to 1.

NILES-BEMENT-POND 30-INCH TURNING AND BORING MILL.

The advantages of the horizontal revolving table of the boring mill over the face-plate of the lathe for chucking heavy pieces are well known. The work does not need to be elevated so high in the boring mill, and it rests on the table by its own weight while it is being centered and clamped. These considerations give the boring mill a great advantage in the


Niles-Bement-Pond 30-inch Vertical Boring Mill.

rapid production of heavy duplicate parts which require chucking operations. To take advantage of these good qualities, the Niles-Bement-Pond Co., Trinity Building, 111 Broadway, New York, has brought out the boring mill shown in the accompanying engraving.

The base and upright are cast in one piece, strongly ribbed to insure stiffness under the heaviest cuts. All bearings are of liberal size, and particular care has been taken to make

the machine run smoothly, and easy to handle. The cross rail is of sufficient depth to insure a minimum of deflection under the strain of the cut, and has a wide face offering a broad bearing to the saddle.

The table is 30 inches in diameter, corresponding with the rating of the machine. It is supported on a spindle of ample proportions running on a step bearing submerged in oil, and it is supported laterally by a long split sleeve, adjustable for wear and having a conical bearing on the bed. This preserves the alignment permanently, and insures a true running table. The working surface of the table, as regularly built, has a 3-jaw combination chuck, capable of holding work from 4 to 25 inches in diameter. In addition to the jaw slides, there are three radial T-slots for bolting on work. The jaw slides are of steel, built into the table. The chuck jaws are reversible and may be readily removed, leaving the surface of the table entirely clear for irregular work requiring special clamping fixtures.

The table is driven by an accurately cut bevel gear which, as may be seen in the illustration, is nearly the full diameter of the swing. The machine is driven by a 4-step cone provided with back-gears giving eight speeds; this number is doubled by the use of the 2-step counter-shaft provided. Thus a range of 16 speeds covers the work for which the machine is adapted by small gradations, insuring the proper speed for each case. The total gearing ratio of 27 to 1 insures a maximum cutting power on large diameters. The turret slide is supported in a saddle which slides on the permanently located cross rail. Either the vertical movement of the turret slide in the saddle, or the horizontal movement of the saddle on the cross rail, may be effected positively through the feed motion provided. There are 16 changes of feed driven by positive gearing, thus making many of them available for screw cutting. The gears regularly furnished with the machine give 16 pitches from 4 to 48 threads per inch. Additional gears may be furnished at a slight extra cost so that the machine may be used for cutting threads of any desired pitch. All the feed changes, including the reversing of the feed motion, which is effected by the lever at the base of the vertical feed shaft, may be effected from the operating side of the machine, thus making the manipulation simple and rapid, and increasing the output of the tool. The turret has five large holes for tool-holder shanks which are securely held in position by large bolts and binder plugs. The flat sides with which the turret is provided give a broad bearing to the back faces of the tool-holders, thus preventing lateral deflection under heavy cuts.

It will be seen that the machine besides being stiff and powerful, is simple in construction and convenient in operation, thus adapting it especially to manufacturing purposes.

BAUSH VERTICAL AND HORIZONTAL MULTI-SPINDLE DRILLING MACHINES FOR STRUCTURAL WORK.

The two multiple spindle drilling machines illustrated in Figs. 1 and 2 have been designed by the Baush Machine Tool Co., 200 Wason Avenue, Springfield, Mass., especially for the Bethlehem Steel Co. for drilling structural steel made in the "Bethlehem" sections, and manufactured by the Grey process. The equipment installed by the Bethlehem Works consists of eight double-head horizontal machines of the type shown in Fig. 1, and four single-head vertical machines as shown in Fig. 2. The vertical machines are arranged in a line, every other machine being placed on a sliding base so as to accommodate the drilling of various lengths when required. The horizontal machines are intended for drilling the flanges of the rolled sections, and the vertical machines are designed for drilling the web. In the case of the horizontal machines, each head takes the thrust of the drilling pressure of the opposite head.

The design of these drills is very plainly shown in the half-tones. The horizontal machines in particular, embody an entirely new departure in multiple drill design, so far as the arrangement of the details is concerned. These are made in two sizes. The capacity of the heads of the larger size is 12 x 48 inches—that is, the adjustable drill spindles will cover any

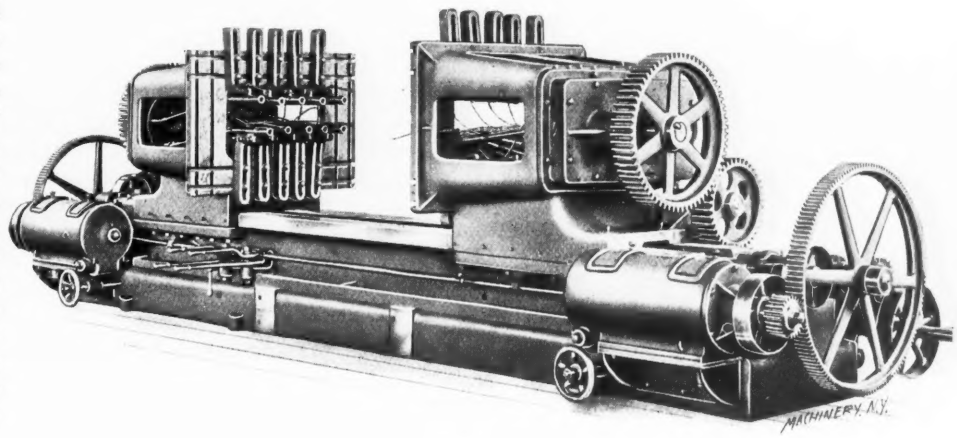


Fig. 1. Double-head, Ten-spindle Baush Horizontal Drilling Machine.

large lay-out within a rectangle 12 inches high by 48 inches wide, eighteen spindles being provided in each head. The smaller size horizontal machine carries heads of a capacity of 12 x 24 inches, each head being provided with ten spindles. This size is the one illustrated in Fig. 1. Both heads on the horizontal machine are operated independently or together, as required. All spindles are provided with No. 3 Morse taper sockets, and the machines are designed for drilling one-inch holes in soft steel, at a speed of 55 feet per minute at the periphery of the drill, with feeds ranging up to 0.01 inch per revolution of spindle. Each head is equipped with an oil pump, pan, reservoir and connections to each spindle, to allow oiling each drill independently.

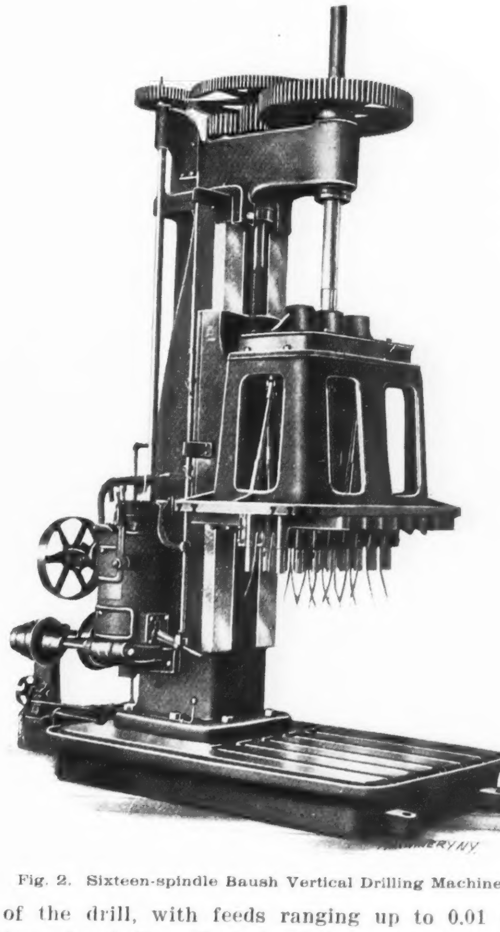


Fig. 2. Sixteen-spindle Baush Vertical Drilling Machine.

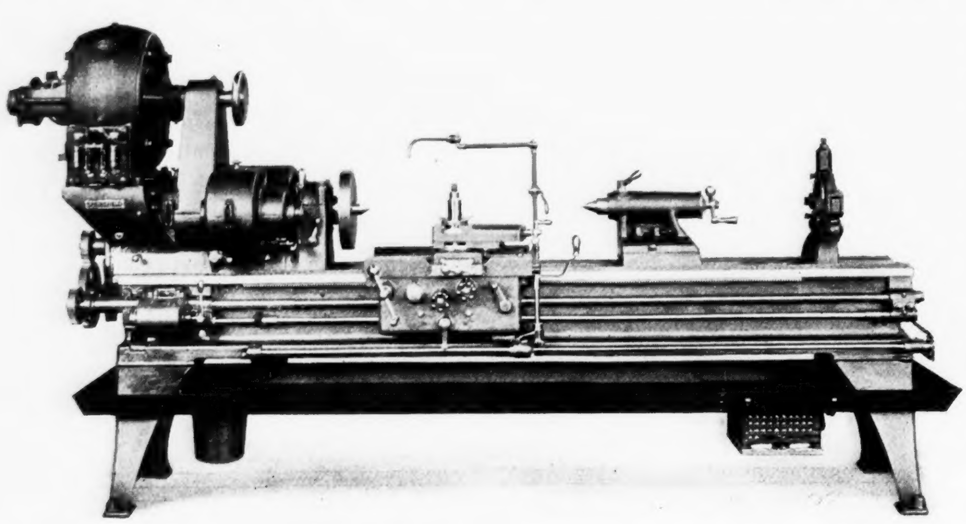
The vertical machines are also built in two sizes, the larger size carrying sixteen drill spindles, and having a capacity of 12 x 36 inches. This is the size illustrated in Fig. 2. The

smaller size carries ten spindles, and has a working capacity of 12 x 24 inches. The spindles in these machines are also provided with No. 3 Morse taper sockets, and designed for drilling holes of the same size at the same speed and feeds as the horizontal machines. The oil pump and oiling arrangement are also of the same character as already mentioned in connection with the machine shown in Fig. 1.

In both styles, the machines are motor-driven, the eighteen spindle-heads being driven by a 25 horse-power motor, and the sixteen spindle-heads by a 20 horse-power motor, while the ten spindle-heads are driven by a 15 horse-power motor. The drills are all provided with a two-speed quick return. The vertical machines weigh about 11,000 pounds, and the double-head horizontal machines about 25,000 pounds, without the motors.

SPRINGFIELD HIGH-POWER MOTOR-DRIVEN LATHE.

The motor-driven lathe shown in the accompanying illustration is built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O., and is known as the company's No. 3 high-power rapid-reduction lathe of 19 inches capacity. One of the most noteworthy features of departure from previous designs is the system of drive employed. On this type of lathe the power is transmitted by means of a silent chain drive, instead of by a train of gears. A heavy, cumbersome construction is thereby avoided, and a neater and more compact appearance given to the machine.



Springfield No. 3 High-power Rapid-reduction Lathe.

The motor is a 7½ H.P. variable speed motor, the speed variations being within the limits of 500 and 1,000 revolutions. The fast speeds of the spindle are obtained by direct drive through the silent chain mentioned, from the motor to the spindle. The next series of slower speeds are obtained through a train of gears consisting of one set of spur gears and one set of helical gears. The smooth action of the helical gears eliminates any chatter marks when taking fine cuts in finishing work. The slowest series of speeds are obtained by a double set of back gears. By the arrangement outlined spindle speeds from 10 to 285 R.P.M are obtainable. The clutches used throughout the geared head are positive steel clutches, but so arranged that the machine does not have to come to a dead stop before changes can be made. A belt-driven model of this lathe is also built, which has ten speed changes for the lathe head itself, which, with a two-speed counter-shaft, gives twenty different speeds. This machine is designed to give a constant cutting speed of 80 feet pr minute for all diameters, from 1½ inch to 18½ inches. When motor-driven, if a constant speed instead of a variable speed motor is used, eight mechanical speeds are obtainable.

The operating lever for the control is placed on the right side of the apron, where it is out of the way of the operator, and yet very convenient of access. The cross-feed screw and compound rest screw have micrometer dials, permitting accurate adjustments. The friction knobs for throwing in and out the gears and longitudinal feeds are made with a series of small ridges around the outer circumference, so that the operator can readily get a good grip. The lathe is equipped with a rapid feed change gear box, which gives six feeds in geometrical progression. The machine shown in the illustration is also equipped with a modification of the change gear system generally in use, but the lathe may also be equipped with the "Ideal" rapid change gear system, used on the lathes of the Springfield Machine Tool Co. Using either system of change gearing, the lathe is equipped with automatic stop and reverse. The latter can be controlled either from the head or apron as desired by the operator.

The machine is of an exceptionally heavy design throughout. The head is heavily ribbed; the spindle runs in large journals, which are oiled by means of babbitt rings of triangular shape, carrying a profuse stream of oil, and thereby preventing any possibility of heating the boxes. The back-gear shaft is oiled in the same manner. In actual tests this lathe has proved itself capable of taking cuts with a feed of 5/32 inch and a cutting speed of 60 feet per minute, with a cut ¾ inch deep in 60-point carbon steel.

BESLY PISTON RING DISK GRINDER.

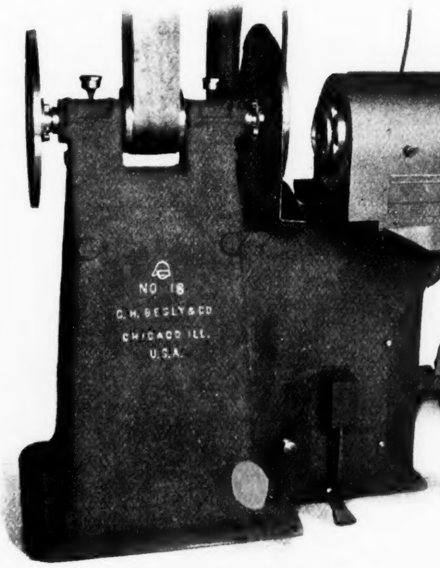
The accompanying half-tone illustrates a new type of grinding machine built by Charles H. Besly & Co., 15-17-19-21 South Clinton Street, Chicago, Ill. This machine has been designed especially for grinding the sides of piston rings rapidly and accurately to size. The novel feature of the machine is that the grinding is done on a steel disk wheel which has its sides covered with Helmet spiral abrasive disks, made by the builders. The machine will grind rings from the smallest diameter up to 10 inches diameter.

The machine as shown carries 18-inch disk wheels. The spindle is 1¾ inch in diameter, and is made from the crucible steel. The bearing bushings are each 8 inches long and are carefully fitted into bored holes in the base casting, thus assuring perfect alignment, as well as making it easy to replace them when worn out. The bushings are split, have removable caps, which are fitted over the bushings, making it easy to remove the spindle if necessary. The end adjustment of the spindle is accomplished by means of a threaded collar, which is mounted on the spindle just under the flange of the spindle pulley. The end thrust is taken on hardened and ground steel thrust collars of large area. The bearings are well protected from dirt and grit, and particular attention is given the lubricating of all bearing parts. The spindle pulley is 7 inches diameter by 6¼ inches face.

On the right-hand side of this machine and secured to the bed, is a dove-tailed bed plate. On this bed plate is mounted a platen or carriage, which has a reciprocating motion, and is moved back and forth parallel to the face of the disk wheel. This motion is attained through a gear and rack underneath the bed, the gear receiving its movement through a crank and lever, the crank being attached to a lower shaft, which is driven by a spur gear meshing with a gear on the worm-gear shaft. This shaft, in turn, projects on the rear side of the machine, and is driven direct from the counter-shaft by a quarter turn belt. On the worm-gear shaft is mounted a clutch, which, upon being thrown in, lets this shaft make four revolutions, and then releases automatically, the four revolutions of this shaft moving the platen ahead and back to its original starting point.

Upon the platen is mounted a compound slide, also having a reciprocating motion, this motion being to and from the face of the disk wheel. The slide receives its motion from a cam which is secured to the outer edge of the bed

plate. Upon this slide is mounted the head or bearings of the spindle which carries the chuck for holding the work to be ground. This head can be moved back and forth at will by means of a screw and hand-wheel, the screw being equipped with a micrometer dial graduated to read in thousandths of an inch. The chuck is of the magnetic rotating type, and receives its rotary motion through bevel and spur gears from the lower shaft in the base of the machine. A sliding gear is provided in the base of the machine, by means of which a rapid or slow motion can be obtained across the face of the disk.



Besly Piston Ring Grinder.

The action of the machine is as follows: The work is placed on the chuck and the lever tripped, the platen moves forward, and the chuck carrying the work moves towards the face of the grinding disk, the work rotating and its entire surface coming in contact with the grinding disk. Thus, instead of grinding in one place only, the whole face is ground at once. As soon as the platen gets to its full forward stroke it recedes, and near the end of the stroke the chuck carrying the work also recedes from the face of the grinding disk. As soon as a full backward stroke is reached, the platen and chuck stop automatically. The principal dimensions are as follows: height from floor to center of spindle, 42 inches; space occupied by base on floor, 30 x 48 inches; weight of machine complete, 3,000 pounds.

GARDNER DOUBLE DISK GRINDER.

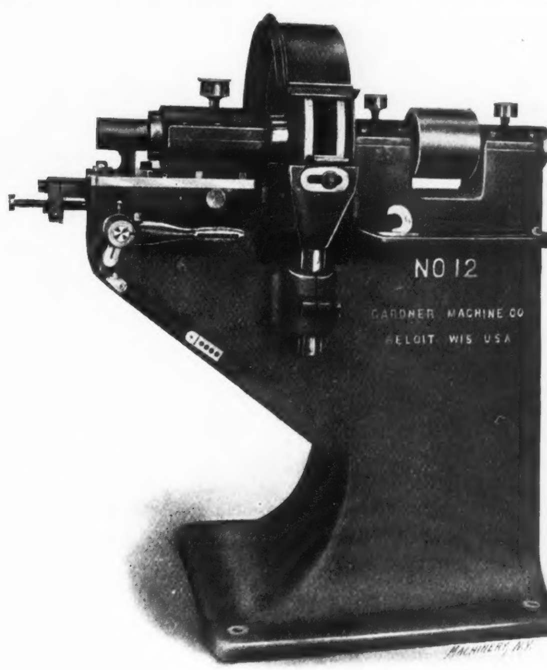
The double disk grinder shown herewith, made by the Gardner Machine Co., Beloit, Wis., embodies what is, so far as we know, a distinctly original idea in its construction—namely, that of having both wheels driven by one pulley and one belt. To accomplish this, the outer disk is carried on a sleeve supported in the adjustable bearing, and is driven by a drive shaft, forming an extension of the spindle on which the other disk and driving pulley are mounted, the sleeve being splined to the drive shaft.

This arrangement, it will be seen, makes possible a very neat design of frame, it being in the form of a column for carrying the fixed spindle, and provided with a knee extending outward to furnish a bearing surface for the slide of the adjustable spindle. The sliding head is equipped with micrometer stop screws and a back stop. The importance of the back stop is not always realized by the purchaser. It comes into play in finishing very thin work, say from 1/4 inch down to 1/32 inch in thickness. It is adjusted so as to allow the disks to be separated just enough to introduce the work, and not enough to allow room for the work to be caught between the work rest and the wheel. The sliding head is operated by means of a hand lever which is directly connected with a steel cut pinion meshing with a steel cut rack fastened to the under side of the sliding head.

To remove the disk from the machine, the driving shaft of the left-hand head is uncoupled from the main spindle. The end of this drive shaft is made with a left-hand thread and a taper shank, the main spindle being bored and threaded to receive it. When this has been removed, the sliding head can be taken off for re-covering the wheels, or the main spindle disk may be used with the machine in this condition, with special work table and fixtures for ordinary flat surface grinding. The disk wheels are fastened to the spindles by the usual countersunk screws.

The machine, as may be seen from the engraving, is rigidly constructed throughout, and great care has been taken in providing lubrication and excluding dust from the wearing surfaces, the hollow spindle being provided with dust-proof collars for this purpose, as well as the main bearings. Disk wheels of either 15 or 18 inches diameter may be used. The maximum distance between the wheels is 4 1/4 inches, which is enough for the great majority of cases, though this may be increased to suit special work. The weight of the machine in the condition shown in the engraving is 1,000 pounds, and when crated for domestic shipment weighs 1,800 pounds. It is furnished with all the necessary accessories, such as setting-up press for the disks, counter-shaft, wrenches, and other supplies.

This machine will be furnished in two other forms besides that shown. In one case, provided with an additional single



Double Disk Grinder driven from Single Pulley.

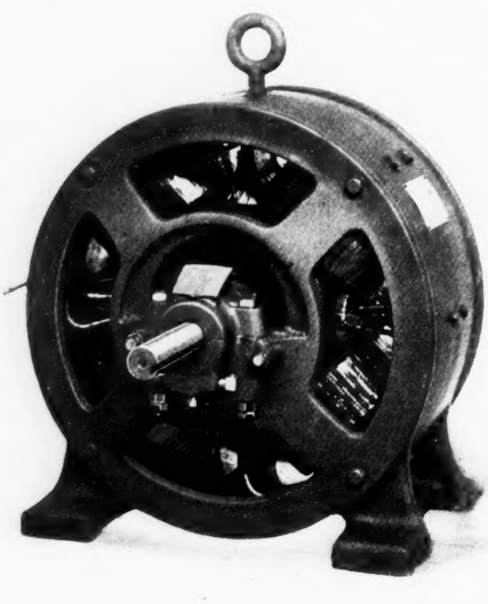
disk at the right-hand end of the main spindle, having the usual tilting table and standard work holding arrangements. This machine will be known as the "No. 12 combination" grinder. The other style, the "No. 12 duplex," will have the same form of double disks, sliding heads, etc., duplicated on the right-hand side of the column, the whole machine being driven by one belt. This arrangement can be used either as a roughing and finishing machine, or, if desired, two men may be employed on the same or different work.

WESTINGHOUSE TYPE "SA" MACHINE TOOL MOTORS.

In order to operate a machine tool with the greatest economy, the speed must be adjusted in each case for the work in hand. The new type SA motor, brought out by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., permits a quick, easy and accurate speed adjustment, and the advantage of the motor drive in this respect as compared with the slow and cumbersome method of shifting belts is apparent. The controller and the motor can be mounted convenient for the operator, and the desired speed can be obtained without stopping the work. It is stated that in one large American manufacturing establishment, where this type of motor was substituted for the older form of power, tests made before and after installing the motors indicated a saving in favor

of the motor of 30 per cent of the cost, as well as considerable improvement in the quality of the product. The speed of these motors can be adjusted within wide limits, simply by moving the controller handle, and the speed, once adjusted, remains practically constant at all loads until further adjustment is made. The number of different speeds obtainable between the minimum and maximum is limited only by the number of notches on the controller. The standard type of SA motors is built in capacities of from ½ to 23 H.P. for speed ratios of 1 to 4, and in capacities of from ½ to 50 H.P., for speed ratios of 1 to 3.

In all type SA motors, the coils on the auxiliary poles are in series with the armature circuit, so that the strength of these poles depends on the load of the motor, and is always proportional to the armature reaction. This is true no matter which way the armature is rotating. The result is that under the brushes is a fixed magnetic field of exactly the right strength to cause sparkless commutation at all loads and at all speeds within the limits of the motor rating, and heavy



Westinghouse Type SA Machine Tool Motor.

overloads can be carried for short periods. The open type SA motor will carry its full rated load at any rated speed for 12 hours or 2 hours, according to its rated time of operation, with a temperature rise not exceeding 72 degrees F. It will carry an overload of 25 per cent for one hour or of 50 per cent momentarily without injurious heating or sparking. The two-hour ratings are satisfactory for intermittent machine tool service, and will give excellent results when applied for such purposes.

WALCOTT & WOOD 20-INCH CRANK SHAPER.

The crank shaper shown in the accompanying half-tones and line engravings is the first of a new line brought out by the Walcott & Wood Machine Tool Co., Jackson, Mich. The details of this line of shapers have been worked out along original lines throughout, and differ in many points from the standard construction with which most shaper users are familiar. The changes are quite largely along the line of increased stiffness and durability, and give evidence of careful attention to small details.

Driving Mechanism.

The machine is of the crank type with the quick return obtained by elliptical gearing. Except for the difficulty of making accurate gearing of this kind, this movement is especially adapted for the quick return motion of a shaper. The action is simple and direct, requiring very few parts, and is exceedingly durable. The methods of manufacture developed by the makers for these gears insure accurate work at reasonable cost, so that the only objection to their use is in a measure removed. The driving connections will best be understood by referring to Figs. 3 and 4 in connection with the half-tone engravings. The 4-step driving cone is mounted on the sleeve *A* which takes the pull of the belt. It drives shaft *B* which has mounted on it double sliding gears which may be made to engage at will, by the operation of lever *C*, with either of gears *D* and *E*. By this means the four speeds given by the cone pulley are doubled, giving

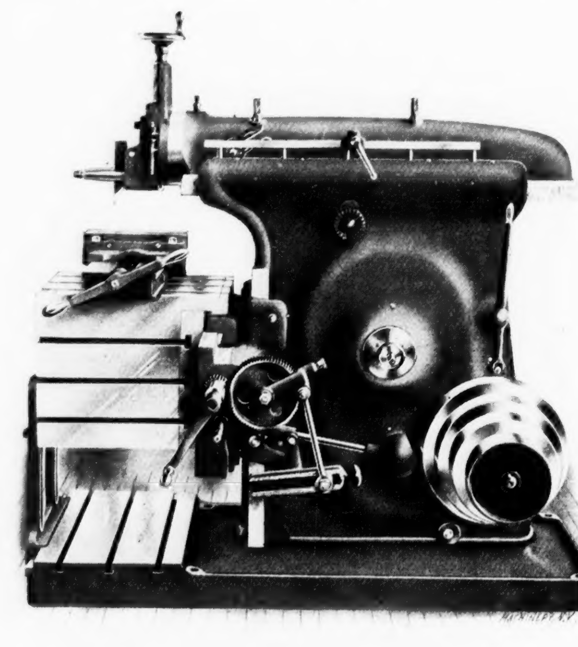


Fig. 1. Walcott & Wood 20-inch Crank Shaper.

eight in all. Pinion teeth are cut in the sleeve on which gears *D* and *E* are mounted, meshing with the bull-wheel *F*. This is keyed to a shaft, the other end of which carries one of the elliptical gears *G* whose mate *H* is attached to and drives the crank *U*.

The slotted link *J* which drives the ram *K* is of unusual length, as may be seen, being pivoted near the base of the machine to link *L*. The upper end is pivoted to block *M*,

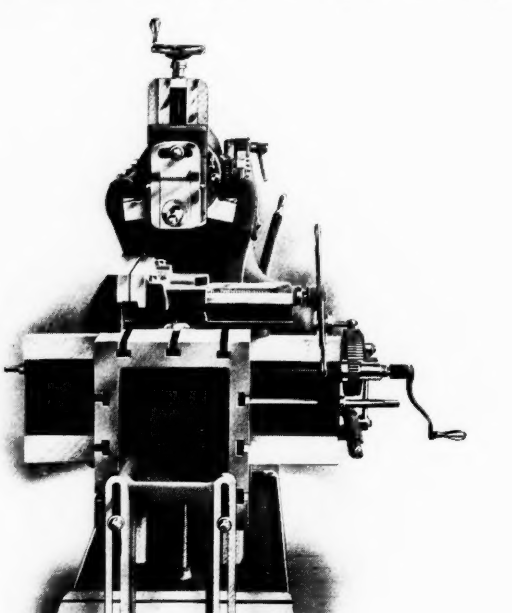


Fig. 2. Front View of Walcott & Wood 20-inch Crank Shaper.

which is supported on ways on the inside of the ram on which it is adjusted by screw *N* which is connected by bevel gearing with squared shaft *O*, by means of which the position of the ram is adjusted. The handle *P* operates a stud with a pinion on the lower end meshing with a rack having a wedge surface which tightens a binding lever, bringing the loose section of the adjusting block *M* simultaneously up against the under side of the ways on the ram and against the adjusting screw, clamping them all tightly. The length of

stroke is adjusted by squared shaft *Q* which is connected by spur and bevel gearing with screw *R* which shifts the position of a crank-pin in the slotted crank. The length of stroke is read from a dial *S* whose pointer is connected by spur gearing and rocks with the ram.

Tool Head and Down Feed.

The tool head is, in the main, of familiar construction, although a number of conveniences and improvements have been made in details. It swivels to any angle through an arc of 90 degrees, and its feed-screw has an adjustably graduated collar reading to thousandths of an inch. A graduated scale and adjustable pointer are provided for indicating the depth of the cut. A strap tool-post is used. The clapper box is strengthened by a tie-rib which connects the two sides, materially strengthening it against side thrust.

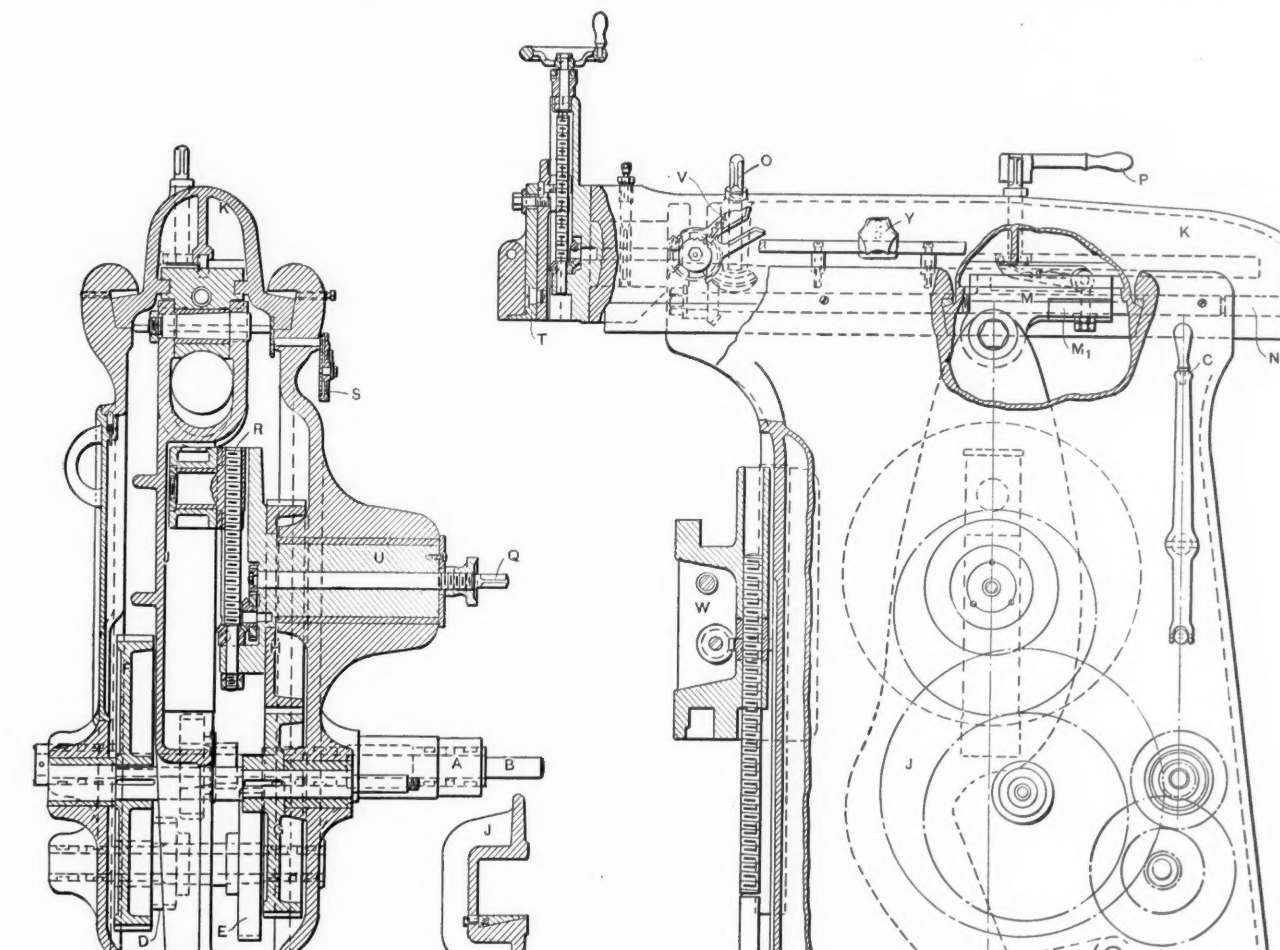
The power down feed is accomplished by positive mechanism acting without the use of springs. It is operated by an adjustable dog *Y* supported on a rail mounted on top of the column. This dog enters the slotted arm *V* at the end of the back stroke, rocking it forward and bringing it back again as the ram reverses. This rocking movement, by means of a ratchet and pawl, is transmitted, through the bevel gearing shown, to the down feed screw. The ratchet is used for connecting or disconnecting the motion. The amount of feed is varied by altering the position of *Y*.

Construction of the Sliding Bearings.

A particular feature of this machine is the method of gibbing used throughout. This is best seen in the case of the ram in Fig. 3. Instead of the ordinary square form of ram bearing with caps screwed on to hold the ram to its work, the construction shown is used, in which the bearing practically surrounds the ram slide on three sides with the solid metal of the column. The ram has flat bearings underneath and a flat wide side bearing tapering slightly outward and upward. The wide top bearing is tapered slightly upward and inward. The lower and side bearings fit the ram surfaces, being planed and scraped to receive them. The space between the tapered upper bearing surface of the ram and the over-hanging lip of the column is filled on each side with a tapered wedge gib set up by screws acting on its edge, thus adjusting them in the direction of their greatest stiffness, producing a uniform contact instead of localizing it under the points of the set-screws as is the case with the usual form of flat gib.

In order to insure the permanent maintenance of the sidewise alignment of the ram, the side bearing, so the builders claim, is 60 per cent greater on this machine than on any other regularly manufactured. The ratio of the lower bearing to the side bearing is calculated to be such that the ram will wear outward so that the wear will be continually taken up on the sides without requiring special provisions for this. By making the upward bearing substantially flat, the wedging tendency that results from the use of 45-degree top bearings, as sometimes used, is eliminated, while the abolishing of screwing on caps goes far toward removing the possibility of the "fan-tail" cut which results from the give of such caps under heavy cuts.

The same principle, so far as possible, is carried out in other bearings. In the case of the rocker arm *J*, a detailed cross-section of which is shown at the right of Fig. 3, a taper gib of the same type has been produced provided with screws for both forcing it out and drawing it in, so that its position can be accurately located. This, in combination with the slight angular displacement of the ram, resulting from its unusual length, as previously described, reduces the wear of the block and the slot to a minimum, and makes it possible to take up whatever wear may occur. The pin about which the arm is pivoted to the adjusting block of the ram, is tapered so that this may be adjusted for wear. The journal of the hub of the slotted crank *U* in the main frame is

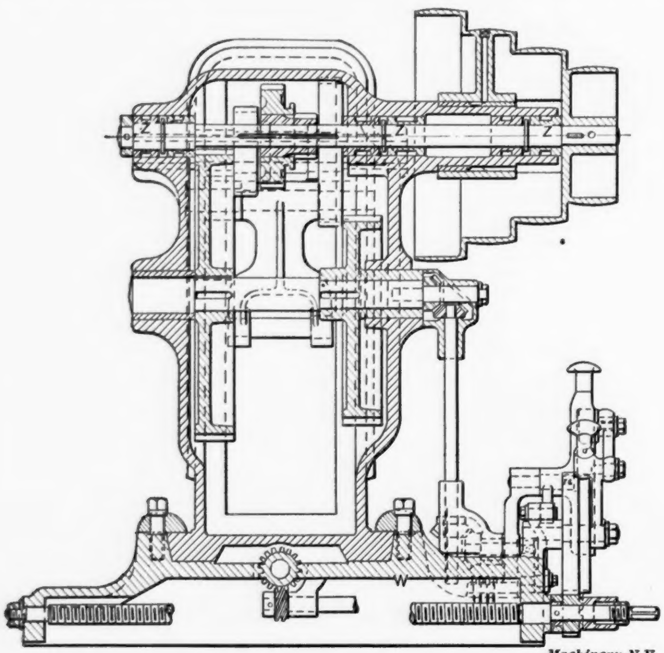


Figs. 3 and 4. Section and Elevation showing Design of Shaper.

unusually long, and its bearing is cast solid with the column. All of this tends to make a strong and durable driving mechanism.

Cross-Rail and Table.

The cross-rail *W*, Fig. 5, is of box form designed to withstand the strain of heavy cuts. The bearings on the front of the column are made with the outside surfaces at a slight angle to provide means for automatically taking up wear in



Machinery,N.Y.

Fig. 5. Transverse Section through Apron, and Column of Shaper.

the same way as is done with the ram bearings. This makes it unnecessary to rely on the pressure of a few gib screws to maintain the alignment. The apron is provided with a gib of the same kind as used in the ram and rocker arm, for taking up the wear. The table is of box form, and can be readily detached. It is locked to the apron in a simple and effective way. An outer support of the practical form shown in Figs. 1 and 2 is supplied with the machine.

Feed Mechanism.

To avoid the necessity for adjusting the feed for various heights of the table, an original feed mechanism has been employed. At the right side of the cross-rail is mounted a bracket which contains a crank connected by bevel gearing and telescopic shaft with the bull-wheel shaft. The crank is connected with a slotted link which is thus vibrated in the proper relation with the ram for the feeding movement. An adjusting screw and knob shifts the position of a trunnion nut in this slotted link to vary the rate and the diameter of the feed. The trunnion nut is connected by a link with the ratchet arm of the feed gear wheel, which, in turn, meshes with the pinion on the cross-feed shaft in the usual way. The pinion driving the cross-feed screw is connected to it by clutch teeth kept in engagement by a spring. This furnishes a safety device so that if the table is accidentally fed to the extreme end of its travel, the resistance of this movement stopping the screw will cause the clutch teeth to be forced out against the pressure of the spring, thus stopping the feed and preventing the breaking of any part.

Details of Construction and Equipment.

In describing the means for adjusting the position of the ram by means of crank-shaft *O*, screw *N* and clamping handle *P*, mention should have been made of the reason for following this plan in place of the usual one in which *M* is clamped by a bolt through a vertical slot in the ram with a handle similar to *P* at the top. The arrangement here used does away with this elongated slot, and thus allows the ram to be ribbed through from side to side above block *M* throughout its whole length. This greatly increases the stiffness of the ram, and its capability for doing heavy and accurate work.

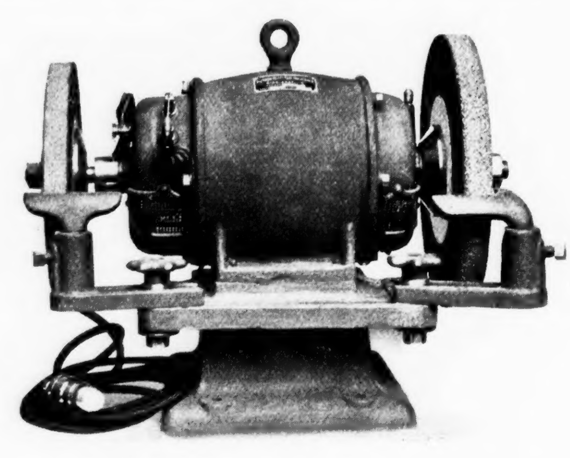
As to the general character of the design and workmanship of the machine, aside from what has already been explained, it may be mentioned that all bearings are bushed with bronze, and all rapid running bearings are provided with ring oilers. The ring oilers for the driving shaft are seen plainly in Fig. 5 at *Z, Z, Z*. The driving cone is provided with bushings with an oil chamber between, arranged so that a splasher attached to the pulley throws the oil over the stem and keeps the bearings thoroughly lubricated. Suitable oiling facilities are provided for all the other running and sliding bearings.

The vise, as shown in the half-tone, is designed to lie down flat on top of the table, giving it a rigid support. It is graduated and provided with a swivel base. All the shafting is of the best quality steel ground to size. The gears are all cut from the solid, and are of coarse pitch and wide face, driven by steel pinions. The maximum stroke of the machine is 20 inches; the horizontal travel, 27 inches; the length of the ram bearing in the column, 36 inches; the down feed of the head, 7 inches. The width of the belt used is 3 inches. The counter-shaft is run at about 350 revolutions per minute. The maximum ratio of the gearing is 32 to 1. The net weight of the machine and counter-shaft is 4,100 pounds.

The line of shapers to which this 20-inch belongs will later include a 16-inch and a 24-inch size, as well, with probably is 4,100 pounds.

U. S. ELECTRICAL TOOL CO.'S BENCH GRINDER.

The electric bench grinder illustrated in the accompanying half-tone is manufactured by the United States Electrical Tool Co., Cincinnati, Ohio. The motor of this bench grinder is of the air-cooled type of 2 H.P. capacity, and made for 110 or 220 volts direct current. It is operated by connecting it directly to an ordinary incandescent lamp socket. The



Bench Grinder built by the United States Electrical Tool Company.

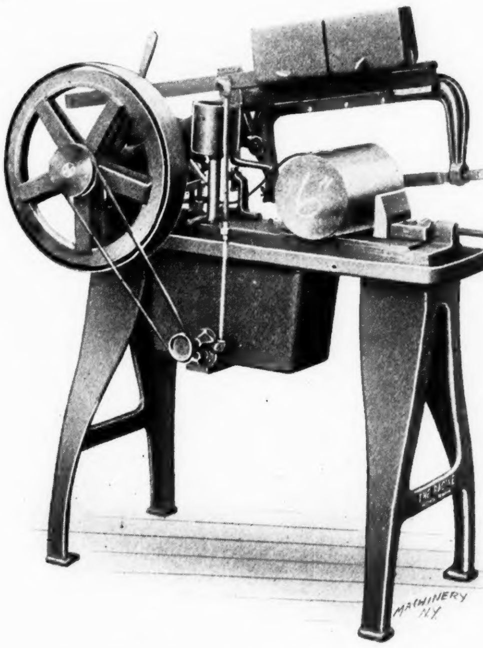
emery wheels used are 12 x 1¼ inch and 10 x 1 inch, respectively. The bearings are conical, dust-proof, and adjustable for wear. The tool rests are adjustable and can be taken off, if required, or swung out of the way. Besides being used for regular grinding work, this grinder is also suitable for buffing or polishing work.

RACINE HIGH-SPEED AUTOMATIC HACK-SAW MACHINE.

The hack-saw manufactured by the Racine Gas Engine Co., Racine Junction, Wis., which was described in "New Machinery and Tools" department in the January, 1908, issue of MACHINERY, has been brought out in an improved form, as shown in the accompanying engraving. As will be remembered, an important feature of the machine is the means provided for positively arresting the saw from contact with the work on the back stroke, thus lengthening the life of the saw, increasing the rapidity of the cutting, and squaring off the end of the work more accurately.

The improved design shown herewith has been especially planned for increasing the rate of production. With this end in view, a tank and pump for a lubricant has been pro-

vided. A cutting compound costing less than 2 cents per gallon is recommended, which is pumped from the tank through a pipe into a reservoir, and thence onto the work, whence it falls into the trough provided around the base of the machine, and then returns to the tank again to be used over continuously as in screw machines and other machine tools.



Racine High-speed Automatic Hack-saw Machine.

The raising of the saw on the return has proved to be of great value in increasing the rate of production. It is also impossible to break the saw by applying too much pressure to it. As much as 80 pounds pressure has been used for a saw blade 14 inches long, 1 inch wide, and 0.032 inch thick, without injury, a 6-inch round bar having been cut off under these conditions in 32 minutes. It is possible, also, to use a thin blade, thus effecting a saving of material.

The use of the cutting compound has made possible a doubling of the speed on a machine of this type, while the length of time that a saw blade can be used is increased from 10 to 40 per cent, according to the size and kind of material to be cut. The blade is also less liable to break.

ANGLE MEASURING INSTRUMENT MADE BY SCHELLENBACH-HUNT TOOL CO.

The Schellenbach-Hunt Tool Co., Cincinnati, Ohio, is making the unique angle measuring device shown herewith in Figs. 1 and 2. This instrument is arranged with suitable multiplying gearing to indicate the position of an adjustable

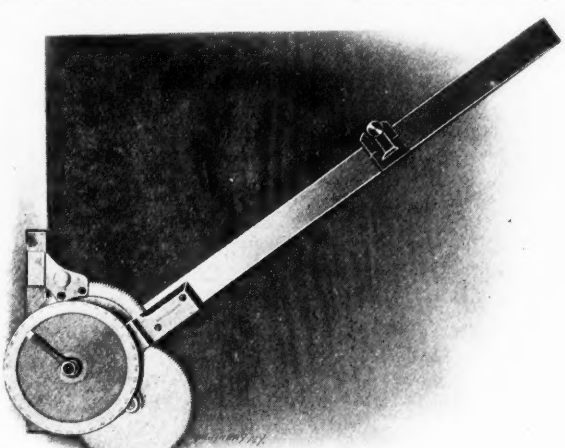


Fig. 1. Schellenbach-Hunt Angle Measuring Device used on the Drawing Board.

straight-edge sector to within one minute in easily read graduations. It may be used for accurate work on the drawing board or for laying out angles for templets on sheet metal and similar work.

The device when used on the drawing board is arranged as shown in Fig. 1. To the straight-edge at the left, which lines the device with the edge of the drawing board, is fastened a stationary gear of 144 teeth about whose center is pivoted the radial arm used for taking off or scribing the angles. The working edge of this arm passes through the center of the pivot. The plate to which this arm is fastened carries a pinion of 18 teeth meshing with a stationary gear and attached to the end of the spindle of a large revolving gear of 135 teeth shown at the right. This gear, in turn, meshes with a pinion of 18 teeth on the spindle which carries the pointer shown, which thus makes 60 revolutions for each full revolution of the arm. The stationary dial around which the pointer travels, is, accordingly, graduated into 360 degrees, each degree corresponding with a minute of movement of the arm. Arranged thus, the arm can be swung around through a half circle.

In the position shown in Fig. 2, the guiding straight-edge has been removed from the fixed gear, and the latter is held to the drawing board by thumb tacks passing through holes in the web of the gear provided for the purpose. In this position the blade is free to move around the whole circle. A sliding block for a scriber or pencil is shown attached to the blade. This can be locked in any desired position on the blade as a stop for the graduations produced. The indicating hand can be set to any desired position in relation to the

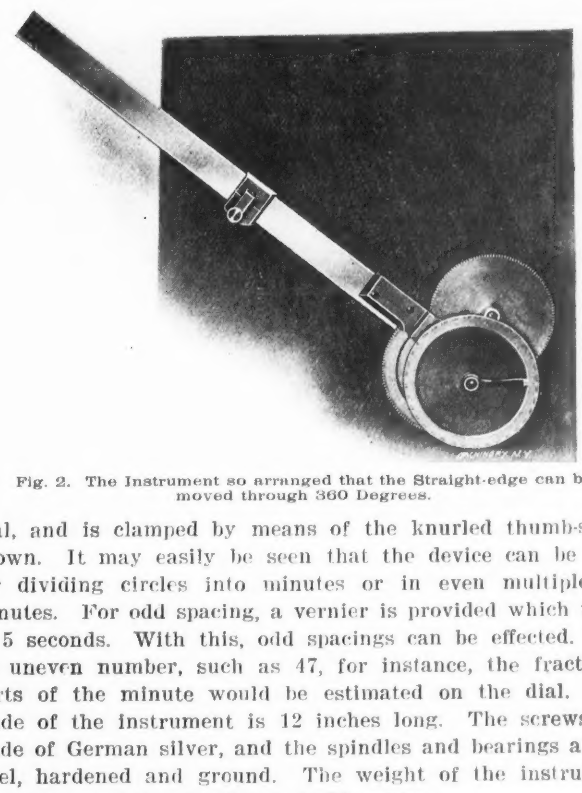


Fig. 2. The Instrument so arranged that the Straight-edge can be moved through 360 Degrees.

dial, and is clamped by means of the knurled thumb-screw shown. It may easily be seen that the device can be used for dividing circles into minutes or in even multiples of minutes. For odd spacing, a vernier is provided which reads to 5 seconds. With this, odd spacings can be effected. For an uneven number, such as 47, for instance, the fractional parts of the minute would be estimated on the dial. The blade of the instrument is 12 inches long. The screws are made of German silver, and the spindles and bearings are of steel, hardened and ground. The weight of the instrument complete, as shown in Fig. 1, is 20 ounces.

KEMPSMITH HORIZONTAL CIRCULAR MILLING AND INDEXING ATTACHMENT.

The Kempsmith Mfg. Co., Milwaukee, Wis., is building a circular milling attachment of the type shown in operation, Figs. 1 and 2. The operations for which it is adapted include circular milling of all kinds, indexing, cutting the teeth of gears, etc., and other operations in which successive portions of the periphery of a piece of work have to be presented to a milling cutter. It should be especially useful in connection with a vertical milling attachment.

The device consists of a circular table, either 14 or 18 inches in diameter as required by the customer, mounted on a base on which it has a solid bearing for almost its whole area. The table may be rotated on its base by means of a worm and worm-wheel, being set at the desired locations either by means of the graduations for degrees marked on its periphery, or by means of the index plate and crank shown in Fig. 2. The plate and crank are the same as used with the regular

spiral head furnished with the universal milling machine, which may be taken off and used with this attachment. Since the ratio of the worm and gearing is the same as that in the spiral head, the index tables are the same for each case. For continuous power rotation, feed connection is made with

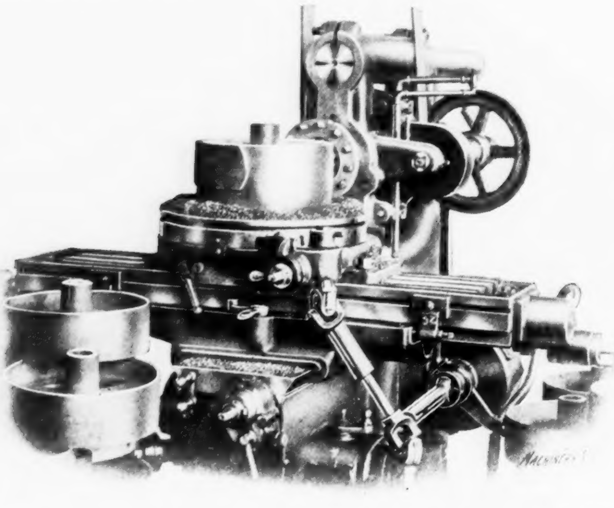


Fig. 1. Kempsmith Horizontal Circular Milling and Indexing Attachment being used for Pulley Crowning.

the feed box on the knee by the telescopic shaft and gearing shown in Fig. 1. A special bevel gear connection encased in a suitable containing bracket is provided for driving the telescopic shaft from the gear box. A clutch provided with an automatic throw-out is used for disconnecting this power feed when required.

The application of the device shown in Fig. 1 relates to the milling of a crowned pulley face. This is done, as shown, by using a round cutter head with inserted blades in its face to finish the face of the pulley, setting the latter with its center slightly off from the center line of the machine spindle. This produces the desired crowning effect which may be varied by altering the longitudinal adjustment of the table. In this case, of course, the power circular feed is employed. In Fig. 2 this power feed is disconnected, and the index plate and crank are being used for dividing a large spur gear. This is of a diameter much too great to be swung on the usual index centers of the machine. Of course, the centers could be mounted on blocks high enough to swing the work, but in that case the cut would be taken so far from the bearing surface of the table of the miller as to make a very unsteady structure and require slow feed. The indexing would also be inaccurate owing to the small diameter of the index worm-wheel as compared with the diameter of the work. In the present case the index wheel nearly approaches the work in diameter. The automatic vertical feed of the machine is used in this case. It will be seen that the strain of cutting is taken vertically downward against the knee which is well able to resist the stress, so that a heavy cut may be taken without chatter or vibration. The gear in this case was 6 pitch, 18 inches in diameter.

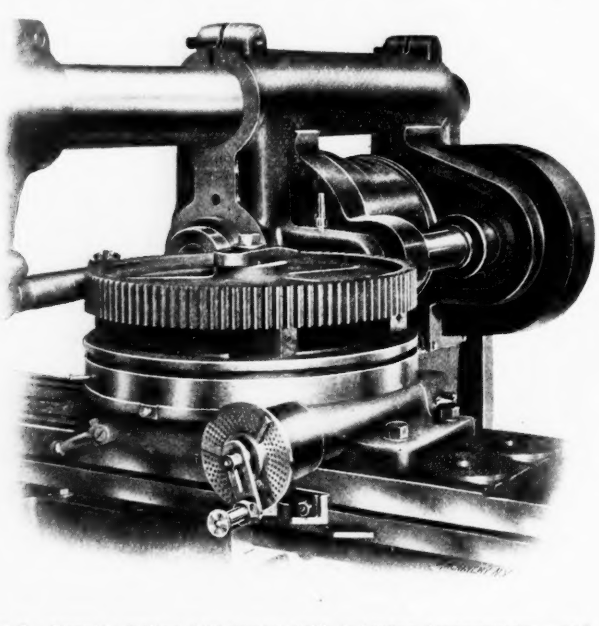
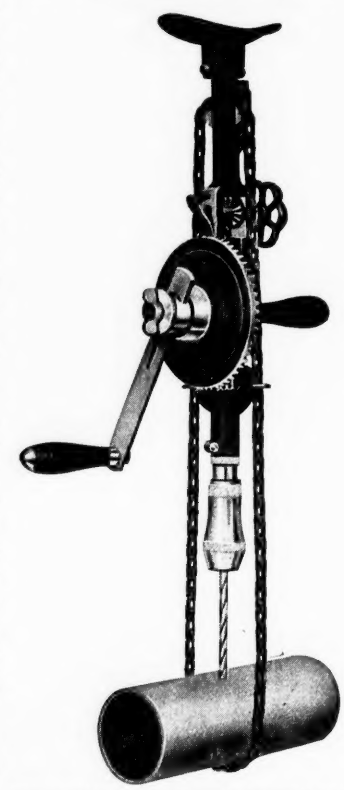


Fig. 2. Circular Milling Attachment with Indexing Arrangement, used for Cutting Large Spur Gears.

The attachment, as stated, is built in two sizes, giving either a 14-inch or 18-inch table. The table can be clamped at any angle throughout the full circle by a patent clamping ring, such as used on the universal millers. The table, if desired, can be released from the worm-wheel for quick adjustment.

UNIVERSAL BREAST DRILL MADE BY THE LANCASTER MACHINE & KNIFE WORKS.

The Lancaster Machine & Knife Works, of Lancaster, N. Y., is placing on the market the breast drill shown herewith which combines a number of useful features. It will be noted that it has a chain feed attachment. This attachment, which is automatic in its operation, and is operated by the supporting handle, allows pipes, beams and similar articles to be drilled with the greatest ease, it not being necessary for the workman to force the tool in by main strength. The machine can be adjusted to any angle, making it useful in working between girders and ceiling joists, and in the interior of machinery where space is limited. Where there is not enough room for a full turn of the handle, the ratchet attachment provided may be used. The tool is provided with two speeds for drills of different sizes, and the radius of the handle is also adjustable. The gears are machine cut. The head and socket have ball bearings, and the handles are cocobolo. The chuck is fitted with four steel alligator jaws which will firmly hold both round and square shank drills. If desired, however, the drill will be fitted with a 3-jaw chuck.



Universal Breast Drill made by the Lancaster Machine and Knife Works.

ECLIPSE POWER HACK-SAW.

The accompanying half-tone engraving, Fig. 1, illustrates a new power hack-saw brought out by the Eclipse Machine Co., Elmira, New York, and known as the Eclipse power hack-saw. An inspection of the general design of the machine plainly indicates that it is a radical departure in its field. The design of the machine makes it possible to cut off stock with greater accuracy than is usually possible with a power hack-saw, it being possible to cut off stock within limits of variation of not more than 0.002 inch for a 4-inch bar; at the same time the machine permits unusually rapid operation. The particular value of the accuracy obtainable is evident, as it saves expense in truing up the faces of the stock, which is usually necessary when stock has been cut off by a hack-saw.

As will be noticed in the half-tone, Fig. 1, the machine is provided with a stop device for setting the stock at any length desired to be cut off. This stop is automatic in its action, and requires a minimum amount of attention. An ordinary 20-inch hack-saw blade is used in the machine, and the stock is turned so as to always present to the saw an easy cutting surface, whereby the saw is saved, and therefore lasts longer than is ordinarily the case. In the line engraving, Fig. 2, the construction of the patented chuck

used in this machine for holding the material is illustrated. It is constructed on a rather novel principle, and will hold any size of round steel from ⅜ inch up to 6 inches in diameter, and square stock up to 4 inches in size. It is quickly operated with a single screw actuating device.

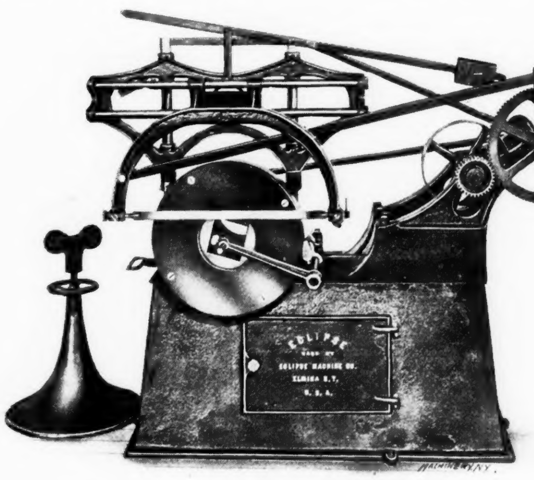


Fig. 1. The Eclipse Machine Co.'s Power Hack-saw.

The power required to run this machine does not exceed one-half H.P. The weight of the machine is 650 pounds, and the floor space required is 4 x 2 feet. The selling agents are Manning, Maxwell & Moore, Inc., 85-87-89 Liberty St., New York.

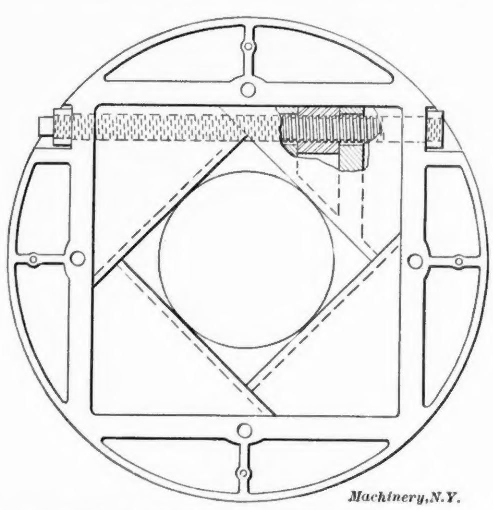


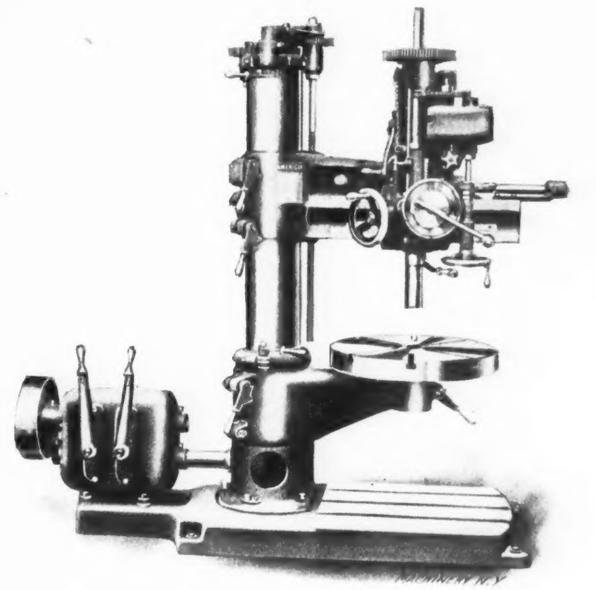
Fig. 2. Chuck of Simple and Ingenious Design used in the Eclipse Power Hack-saw.

AMERICAN TOOL WORKS 2-FOOT RADIAL DRILL.

The American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, is building the 2-foot radial drill shown herewith. This neat looking tool is an evidence of the inherent adaptability of the radial drill press, which is evidently proving itself useful in sizes which nearly come into competition with the old standard form of upright drill press. Of course, it goes without saying that any tool of this kind placed on the market in these days is designed with special reference to the use of high-speed steel tools. This would be plainly seen in the weight and massiveness of the parts even if no special mention were made of the fact.

The base is strongly ribbed at the point where the column is attached to it. This latter part is of the double tubular form. The sleeve or outer column revolves on conical roller bearings, hardened and ground, and may be clamped in any position by the builders' patented clamping ring which may be moved by the column to suit the convenience of the operator. The clamping of this makes the outer column practically integral with the inner one, which latter extends almost to the top of the outer column, having full bearings both at top and bottom. The arm is of combined parabolic beam and tube sections, giving greatest resistance to both bending and torsional strains. This design leaves the lower line parallel with the base, and thus permits work being operated on in close proximity to the column without the necessity of an extreme reach of spindle. The arm is raised and lowered rapidly by a double thread coarse pitch screw controlled by a conveniently placed lever. Arrow points provided, located on the column cap, indicate the direction of the movements obtained.

The spindle has 16 changes of speed obtained from a 2-speed counter-shaft, a 4-speed gear box, and a back-geared head. These changes being instantly obtainable and in small increments, give the workman the fullest facilities for driving his tool, whether a drill, tap, or counterbore, at the proper speed. The gear box is very powerful, of the geared friction type. The four speeds provided are instantly available through the operation of the two levers shown. This form of box makes it possible to change the speed with absolutely no shock, even under the most severe conditions. The back-gears are located on the head so that all the connecting shafting and gearing between the driving belt and the head operate at high speed and low torque. These gears may also be engaged and disengaged without shock while the machine is in operation, by a lever convenient to the operator, the high-speed movement being engaged by a friction clutch.


American Tool Works 2-foot Radial Drill.

TWO-FOOT ARM BACK-GEARED HIGH-SPEED RADIAL DRILLING TEST IN CAST IRON TWO INCHES THICK.

Size Drill.	Speeds.		Feeds		Back Gears.		Actual H. P	Amperes.	Volts.
	Revolutions.	Cutting Speed.	Per Revolution.	Inches per min.	Ratio.	Position.			
$\frac{3}{4}$″ H.S.	290	56.9	.015″	4.35	1.5	Top	2.78	9	230
$\frac{3}{4}$″ H.S.	406	79.7	.020″	8.12	1.5	Top	6.18	20	230
$1\frac{3}{32}$″ H.S.	290	83.	.020″	5.8	1.5	Top	6.18	20	230
$1\frac{3}{32}$″ H.S.	406	116.2	.020″	8.12	1.5	Top	9.9	32	230
$1\frac{15}{32}$″ H.S.	290	111.4	.015″	4.35	1.5	Top	9.25	30	230
$1\frac{15}{32}$″ H.S.	290	111.4	.020″	5.8	1.5	Top	12.4	40	230
$1\frac{29}{32}$″ H.S.	207	79.5	.007″	1.4	1.5	Top	5.25	17	230
$1\frac{29}{32}$″ H.S.	207	79.5	.020″	4.14	1.5	Top	12 4	40	230

The head is adjusted on the arm by a hand-wheel through an angular rack and spiral pinion. It may be clamped to the arm in any position. The feeding mechanism in the head provides for four distinct rates in geometrical progression, carefully chosen, ranging from 0.007 to 0.020 inch. They are obtained by turning the knob shown just below the feed box until the feed desired, on the dial, comes opposite a fixed pointer. This obviates the necessity of referring to index plates in connection with the handling of levers. Positive-geared feeds of this type insure greatly increased productive

capacity, especially when using drills which can be pushed as hard as those made of modern high-speed steel. A friction member is provided in the drive, which allows the drill to be crowded to its limit without danger of breaking any of the mechanism. The feeds can be automatically tripped at any position of the spindle by an adjustable dog. Depth graduations are provided on the spindle, and all depths can be read from a datum point. The safety stop acts automatically at the full depth of the cut in preventing breakage of the feed mechanism. The tapping mechanism is carried on the head between the back-gears and the speed box, thus giving the friction clutches, though powerful in themselves, the added benefit of the back-gear ratio. This makes unusually heavy tapping operations possible, and also permits taps to be backed out at an accelerated speed. A lever for starting, stopping and reversing the spindle is controlled from the head at the front of the machine.

TWO-FOOT ARM BACK-GEARED HIGH-SPEED RADIAL DRILLING TEST IN STEEL THREE INCHES THICK.

Size Drill.	Speeds.		Feeds.		Back Gears.		Actual H. P.	Amperes.	Volts.
	Revolutions.	Cutting Speed.	Per Revolution.	Inches per min.	Ratio.	Position.			
3/4" H.S.	406	79.7	.007"	2.84	1.5	Top	5.25	17	230
3/4" H.S.	406	79.7	.011"	4.46	1.5	Top	12.4	40	230
3/4" H.S.	290	56.9	.020"	5.8	1.5	Top	5.9	20	220
1 1/32" H.S.	290	78 3	.011"	3.2	1.5	Top	5.9	20	220
1 23/32" H.S.	106.5	47.9	.011"	1.17	5.72	Btm.	8.3	28	220
1 27/32" H.S.	76	36.6	.011"	.84	5.72	Btm.	5.3	18	220
1 27/32" H.S.	76	36.6	.015"	1.14	5.72	Btm.	6.2	21	220
1 27/32" H.S.	76	36.6	.020"	1.52	5.72	Btm.	8.3	28	220

The accompanying tables give the results of tests made on one of these machines. The builders believe that these records are quite remarkable in the amount of power the machine will permit from the drive to the point of the tool.

TWO-FOOT ARM BACK-GEARED HIGH-SPEED RADIAL TAPPING TEST WITH PIPE TAPS IN CAST STEEL ONE AND ONE-EIGHTH INCH THICK.

Diameter Tap.	Speeds.		Feeds.		Back Gears.		Actual H. P.	Amperes.	Volts.
	Revolutions	Cutting Speed.	Per Revolution	Inches per min.	Ratio.	Position.			
2 1/2"	38.5	28.9	1/8"	4.8	5.72	Btm.	9.14	31	220
3"	38.5	35.2	1/8"	4.8	5.72	Btm.	9.7	33	220

TEST IN CAST IRON ONE AND ONE-EIGHTH INCH THICK.

2"	40	24.8	1/11½"	3.4"	5.72	Btm.	4.24	14	226
2 1/2"	40	30.1	1/8"	5"	5.72	Btm.	5.15	17	226
3"	40	36.6	1/8"	5"	5.72	Btm.	5.75	19	226

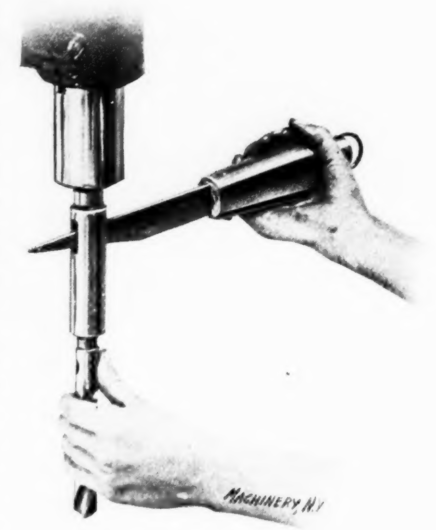
They call especial attention to the rate at which the 3-inch tap was operated in steel and cast iron, which was at the rate of 35.2 and 36.6 feet per minute, respectively.

Although the machine is shown arranged for single pulley drive through a speed box, it will also be provided with a cone pulley, if desired by the purchaser. The speed box arrangement is easily adapted to direct motor connection which may be made in a number of ways, though the builders recommend that the motor be mounted on the base beside the speed box and be connected to it by gearing.

AUTOMATIC DRILL DRIFT.

The drill drift illustrated in the accompanying half-tone is a practical appliance which undoubtedly will be appreciated in modernly equipped machine shops. It is known as the "automatic drill drift," and is manufactured and marketed by the Automatic Drill Drift Co., of Springfield, Ill. When in operation, the drift or blade is inserted in the slot in the drill socket and the drill is removed simply by sliding the heavy handle over the blade, until the base of the blade strikes against the bottom of its socket in the handle, this impact being sufficient to remove any drill. The tool consists of a hardened, polished steel blade, mounted in the heavy handle, as shown, in combination with a low tension coil spring placed behind the base of the blade in the handle. This spring serves to keep the blade permanently in its extended position, excepting when in operation.

The most pronounced advantage of the tool is that the drift and the driving mechanism are self-contained, requiring only one hand to operate the device, the other being free to hold the drill and prevent it from falling, as it invariably does when the operator is compelled to use one hand to hold the drift, while he drives it home with the other hand, by means of any object in sight. The size of the tool makes it practically universal for all ordinary purposes, as it will fit Morse sockets from No. 1 to No. 3 inclusive. A ring is provided at the end of the handle, by which it may be attached by a chain to the drill press, so as to always keep it in place, handy and ready for use. This tool, being so simple and inexpensive, should prove very useful in the machine shop, where it should cure the practice of driving drills out of their sockets by unsuitable appliances.



A Tool which combines Drill Drift and Hammer.

ARMSTRONG-BLUM MFG. CO., 113 N. Francisco Ave., Chicago, Ill. Hack-saw designed so that a drawing cut is produced, thereby doing away with the common tendency of buckling the saw blades. The blade is automatically raised on the return stroke by the action of a spring, which latter is so placed as to give the required pressure on the cutting stroke.

FERRACUTE MACHINE CO., Bridgeton, N. J. Foot press provided with a gang of one hundred 5/8-inch punches and dies for cutting paper blanks. The punches are hollow, each punch containing an ejector pushing the blanks through the lower die into brass tubes provided for their reception. The stroke of the press is 4 inches, and the total weight of press and dies, 2,750 pounds.

TECHNICAL SUPPLY CO., New York City. Duplex blue-printing machine for the continuous printing of blue-print, VanDyke, or other papers. Two Cooper-Hewitt lamps are used and two strips may be printed at once, at speeds varying from a very slow rate for black process papers, up to 4 or 5 feet per minute for fast printing papers. The rate of printing for the two sides of the machine is independent.

BUFFALO SPECIALTY CO., Buffalo, N. Y. Tandem hack-saw of original design, providing for two complete hack-saws in one frame, the object being to use the minimum amount of power, one saw cutting while the other saw is reversing. The saws are held out of contact with the work on the return stroke. Each saw has a capacity for cutting 5x5-inch stock with a stroke of 6 inches. The saws run at from 85 to 110 strokes per minute.

BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y. Steam hammer, differing from the usual construction in that the anvil block is cast solid with the main frame, enabling the hammer to be used for small drop forging as well as for ordinary steam hammer forging work. The hammers are rated by the

actual scale weight of the falling parts, without counting the force of the blow from the pressure, and run from 100 to 300 pounds. The hammers can be run either by steam or compressed air without change.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., E. Pittsburg, Pa., after consulting prominent steel engineers, has placed on the market a motor especially designed for rolling mill service. It is thoroughly protected against dust, is provided with ample wearing surfaces, with plenty of clearance between the running and stationary parts, so that the machine will run indefinitely before they come in contact. The insulation used throughout is strictly incombustible, and will stand very high operating temperatures without deterioration.

STRONG, CARLISLE & HAMMOND CO., Cleveland, Ohio.—Oil tempering furnace constructed so that the path of the flames strike the baffle wall under the oil tank, and are then deflected to the outer walls of the combustion chamber and to the sides of the oil tank. The furnace is equipped with a thermometer registering up to 760 degrees F., and with a chain hoist for raising and lowering the material which is contained in a heavy iron basket. The gas consumption per hour is 70 cubic feet; the floor space occupied is 36 x 37 inches; the capacity of the basket is 200 pounds.

CORBIN CHURCH CO., Plainville, Conn., is building a manufacturer's drill of single or multiple spindle type for drills up to 3/4 inch diameter. The feed is 4 1/2 inches. Each spindle has an automatic feed control which disconnects the feed when the drill has reached the proper depth, and returns the spindle, again re-engaging it when the operator is ready with a new piece of work, thus saving time in duplicate manufacturing. Combined with this feature is a device for automatically disengaging the feed when the drill point strikes a hard spot or other obstruction to its normal progress.

C. J. TOERRING CO., 2121 Toronto Street, Philadelphia, Pa.—Machine for drying blue-prints. The machine consists of a series of small rollers revolved by friction contact with a larger heat roller revolving around a heat coil. The prints pass through a washing tank on the end of which the machine is mounted, and are fed into the dryer directly from the tank. This machine enables from 1,000 to 1,500 blue-prints of ordinary size to be handled in a day. It is run by a 1/20 H. P. motor; it runs at a speed of approximately 8 feet per minute, and requires 1 1/2 K. W. per hour for heating.

G. W. FLEMING CO., Bradford, Pa. A sensitive drill press of which the most original feature is a provision by which the spindle speed is changed by the lever for feeding the drill. Swinging this lever downward around the horizontal axis feeds the drill, as with the usual construction. Swinging the lever sideways shifts the friction roll in or out across the face of the driven disk on the spindle, changing the spindle speed. The speed can thus be altered while drilling is in progress, if it is found that a change is necessary, without removing the hands from the feed lever or the work.

EDWIN HARRINGTON, SON & CO., INC., Philadelphia, Pa. Four-spindle locomotive frame drill built specially for the American Locomotive Works. Each of the heads is independently driven by a 6-horse-power variable speed motor. The minimum center distance between the drills is 28 inches, and the maximum center distance between the two outside drill heads is 34 feet 8 inches. The spindles can be brought within 16 inches of the top of the table, the maximum distance being 36 inches. The speed range is from 50 to 120 revolutions with, and from 100 to 300 without, the back gears. The feeds vary from 0.005 to 0.015 inch per revolution. The machine has a capacity of drilling four 2 1/4-inch holes simultaneously in steel, and weighs 46,600 pounds.

* * *

Our present educational system requires that a boy or girl leave school to learn to make a living.—*Common Sense.*

AN AMERICAN MECHANIC IN EUROPE—4.

THE FOURTH OF A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

PARIS, FRANCE, June 17, 1908.

During the time which has elapsed since my last letter from Turin, Italy, the writer has visited the western part of Germany, following the Rhine Valley from Mülhausen, Elsass, to Düsseldorf, and has had an opportunity to meet most of the prominent machine tool builders and a large number of dealers in the cities along this route. It is difficult to give an exact statement of the present conditions of business. Dealers who have a large territory, and who sell a great variety of machinery and tools, and who, therefore, ought to be the ones best informed, say that the machine tool trade is dull throughout the country and that no improvement worth mentioning has taken place. Many dealers carrying on a smaller business, however, are reporting a fair amount of trade, and also that some improvement is noticeable. The machine tool shops are working with full, or nearly full, force and on full time, in this part of Germany. Some machinery, especially of the common types and sizes, is made for stock, but not to any large extent. Messrs. de Fries & Co., Düsseldorf, who are prominent both as dealers and manufacturers of machine tools, said that business is not good, but that there is no real cause for complaint. In their shops, where they usually employ about 800 men, the force was reduced about ten per cent, but the men remaining worked full time.

The railroad equipment shops here have, at the present time, large orders on hand from the various German state railways. This, of course, influences the machine industry throughout the country. In general, it can be said that Germany is carrying the industrial depression with less effect than America. The different business methods in vogue, the longer time of delivery for machines ordered, etc., are, of course, important factors; but one factor which greatly influences trade conditions is the German policy of government ownership of railroads. The state railways do not take into consideration a temporary industrial depression in ordering the material needed. Private roads, on the other hand, when a country is afflicted with a trade depression, refuse to buy and to equip themselves for future demands, and wait until times become better. This, of course, makes a trade depression still more pronounced, at the same time as it makes the crowded business in good times still more crowded. The machine tool industry, which depends to so great an extent directly or indirectly on the demands of the railroads, is thus benefited by the public ownership of the German railroads.

Wages in Germany.

In the letter in the June issue, the writer gave some figures relating to the wages paid in the machine tool industry in Italy and Switzerland. In Germany the wages paid depend upon the location of the shop, differing with the cost of living, the highest wages being paid in Berlin and its vicinity. In the northern part of Germany wages are generally higher than farther south. The Locomotivefabrik Krauss & Co., Munich, gave the following figures representing the average earnings of the men employed in their shops: Boiler makers, M. 5.50 ($1.32); blacksmiths, M. 5.70 ($1.37); machinists, M. 5.00 ($1.20); and unskilled laborers, M. 3.80 ($0.91), all based on a ten-hour day. Generally speaking, the wages in Saxony and along the Rhine are about 10 to 15 per cent higher than those quoted, and in Berlin from 20 to 40 per cent higher.

In a letter from the firm of R. Wolf, Magdeburg-Buckau, received recently in reply to an inquiry on this subject, the following information as to wages was given: Skilled machinists, 60 pfennigs (14.4 cents) per hour; pattern makers, 58 pfennigs (13.9 cents); unskilled laborers, 35 to 42 pfennigs (8.4 to 10.1 cents). Shop foremen receive on an average M. 200 ($48.00) per month, and draftsmen who have no technical school training, M. 150 ($36.00) per month. The workingmen in the shop are kept until the age of about sixty to sixty-five years, and old-age pensions are paid, amounting to from one-third to one-half of the wages of the last year in service, according to the length of time the employe has been in the firm's employ. This firm has a regularly installed apprentice-

ship system, the time of serving the apprenticeship being four years. The apprentices get, during these years small pay, increasing from year to year. There is no special trade school in this factory, but the apprentices are bound by contract to attend the artisans' and manual training schools of the city. Besides, the apprentices, like all boys without high-school education, attend the public evening schools up to the age of 17.

As remarked in a previous letter, the European wages are, when directly compared with those paid in America, very low; but it is not proper to make a direct comparison, because there are some other factors which count, besides the one of 4.17, the ratio between the American dollar and the German mark. These other factors must be taken into consideration in order to get a fair comparison. Living expenses here are somewhat cheaper, the work is more steady, and the workman who is carrying out his duties faithfully, does not live in such a fear of being laid off or thrown out of work as soon as business becomes ever so little "slack," which is so common in America; neither does he fear being laid off because of old age as early as is the case in America. The most important of all the factors to be considered, however, is the old-age pension paid by most—probably all—the State governments in Germany, and in some instances by the manufacturing concerns themselves. Two-thirds of the premium for the state pension is paid by the employer, and one-third by the employe himself. Having his old age thus reasonably well cared for, the working man can afford to expend a larger percentage of his earnings on his current living expenses.

Some Things Seen in the Shops.

When visiting the shops of Messrs. de Fries & Co., Düsseldorf, the writer took special interest in their screw-cutting practice. According to the works manager, screws of all descriptions—with few exceptions—are milled. For executing the common screw-cutting work by milling, ordinary screw-cutting lathes are rigged up with a milling attachment, which takes the place of the tool-post. The milling attachment is driven by belt or rope from an overhead drum. It is provided with a graduated scale by means of which the depth of the thread can easily be read off and adjusted. The rotative speed of the cone pulley is, of course, very much slower than that used for cutting the screws in the ordinary way. It is claimed that the greatest advantage of this practice of milling screws, over that of cutting them in the regular way is that unskilled labor can be employed, and that time is saved by this method because of the fact that one man is able to run more than one machine, the machine practically taking care of itself as soon as it is well started and the milling cutter is fed to the proper depth of thread.

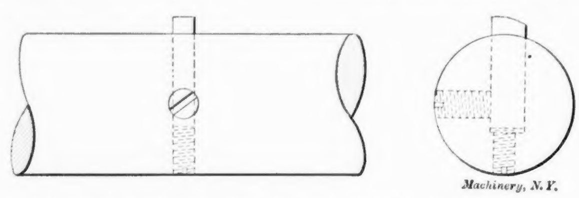
Because the lead of a screw being cut always depends upon the lead of a thread that has been previously cut, any incorrectness in the master thread (as in a lathe, in the thread of the lead-screw) will be reproduced in the screw. For ordinary purposes, the errors in the lead of lead-screws of lathes of good manufacture is insignificant, but occasions arise when these errors must be taken into consideration. In order to avoid the duplication of errors of this character, Messrs. de Fries & Co. have designed a new screw-cutting lathe, working on the principle of producing a thread independently of a previously cut lead-screw. The lathe employed for this purpose is of common design, the feature of extraordinary interest being the arrangement for feeding the carriage; a flexible steel band is used for this purpose instead of the lead-screw. This band is located centrally between the two ways of the bed, and one end of the band is fastened to the front end of the carriage, while the other end extends under the head-stock and is fastened to a drum, turned accurately to a definite diameter. When this drum is revolving, the steel band is wound up on it, and thus feeds the carriage. The drum, of course, must be large enough so that the steel band when winding up does not reach fully one complete turn around the drum, because if it reached more than one turn around, the band in winding up on itself, would be wound up on a larger diameter than that of the drum, thus causing incorrect results. The drum is driven from the cone pulley by means of a worm and worm-wheel.

For the return, another steel band is fastened to the rear end of the carriage, this band extending to the rear end of the lathe, and running over an idle pulley. A counterweight is suspended from this band heavy enough to pull the carriage back, when released from the pull at its front end. This lathe is not used for cutting the whole screw from start to finish, but simply for finishing the thread. The arrangement is by its construction too weak to stand up for the heavy cuts necessary for rough threading. The thread is therefore cut in an ordinary screw-cutting lathe, somewhat over size, and then placed in this special lathe mentioned, and there finished. The inventor of the device, the works manager of the company, claimed that by this machine it was possible to cut the most correct thread as yet produced for commercial purposes.

Threading Large Holes in Cast Iron Press Stands.

While visiting the shops of the firm of L. Schuler, Goeppingen, Germany, the writer took some interest in the method employed for threading large holes in the stands for the presses made by this company for sheet metal work. These presses are friction- and screw-driven, and a hole located at the top of the stand has to be threaded to take the screw which is to execute the whole actual pressing action, this screw varying for different sizes of presses from about 3 to 5 inches in diameter. As no inserted bushing is used, the thread is cut into the stand itself.

For the carrying out of this operation the stand of the press is put up in a heavy lathe, so that the center of the hole comes in line with the lathe centers. A heavy boring-bar is then used, one end of which is clamped in a chuck, mounted on the lathe spindle, and the other end extending on the other side of the hole to be threaded, supported only by a heavy steady-rest. The thread to be cut is of square cross section, and the cutting tool used is shown in the accompanying engraving. A square thread cutting tool is inserted in the boring-bar, being clamped on one side by a small headless set-screw, and fed into the work from the other side by a screw



Section of Boring-bar with Inserted Square Threading Tool.

at the rear end of the tool. In order to save the edge of the tool, it is taken out each time after passing through the work, before the work is returned to the original position; then the tool is inserted again at the front end of the hole, the tool being, at the same time, fed forward by means of the screw at the rear end of the tool, and a new cut started. A complete set of different sized boring-bars and tools for different diameters is, of course, necessary to meet the different requirements of the different sizes of holes to be threaded.

Machining Change Gears.

"Racquet's" article of the above title, in the April issue of MACHINERY, reminded me of a way of finishing change gears which I saw used in another German machine tool building shop. The first operation was to bore the hole in the blank. This was done in a vertical boring mill, and in this machine, also, both ends of the boss were finished by an ordinary facing tool. When the blank was finished so far, it was put on an arbor in a vertical milling machine, and the three surfaces on the rim, that is, the two sides and the outside cylindrical surface were here milled to the finished size in one cut by a gang milling cutter, consisting of one cylindrical cutter for the cylindrical surface of the blank, and two side milling cutters for milling the sides of the blank.

In another German shop the outside cylindrical surface of a gear blank was not finished at all by turning, only the sides of the rim being finished. In order to finish the cylindrical surface, the cutters for milling the teeth were so made that the teeth were finished on the top at the same time that the flanks and bottoms of the teeth were milled and finished. It seems as if this method would represent some saving in the cost of manufacturing the change gears, al-

though it might, to some extent, be done at the cost of the accuracy of the product obtained. The increased cost of milling cutters must also not be lost sight of.

Pickling Castings.

Great attention is paid to the proper pickling of castings. It is fully realized that the pickling process is not merely of advantage as a cleaning process, but that the greatest advantage of it is to be found in the softening effect upon the scale or skin of the castings, the tool not becoming dull as soon as if the casting had not been subjected to a proper pickling process. The most common solution used in Germany appears to be one of 20 per cent sulphuric acid, diluted in water. The solution is applied to the castings, not merely by putting the castings in the solution, but by forcing the solution against the castings through a large jet.

Cutting Metals by Oxygen.

In my letter in the May issue of MACHINERY reference was made to some work done by the oxy-hydrogen, or, more correctly, perhaps, the oxygen blow-pipe method of cutting iron at the Borsig Works, at Tegel, near Berlin. Some more detailed information about the use of this method may be of interest. As is well known, the principle involved in this method of cutting iron is the use made of the oxidizing effect on the metal, or, in other words, the iron is burned away. In order, however, to cause rapid combustion of the iron when the oxygen is applied to it, it must be heated to a temperature of 1,300 to 1,500 degrees F. before applying the oxygen. This pre-heating of the iron is accomplished by a burning jet of hydrogen and oxygen. The apparatus for cutting the iron consists of two nozzles, arranged to follow each other, the first nozzle pre-heating the iron, and followed by the second nozzle for the application of the oxygen, this causing combustion of the iron, and executing the cutting. The two nozzles are arranged so that the oxygen will always strike exactly the same spot which has been pre-heated by the preceding flame. It is important that the cutting nozzles be moved at a certain correct speed. If the cutting nozzles are moved too slowly, the continuous cutting will be interrupted, because the iron will get time to cool off before being struck by the stream of oxygen from the second jet. If, again, the nozzles are moved too quickly, the oxidizing effect will not be complete, and the cutting will not reach through the piece to be cut. With some practice, however, it is not difficult to learn by experience the correct speed for any particular work. When properly done, a cut made by this method is very smooth and equals a sheared cut.

It might be assumed that the material would be severely attacked on the surface by the influence of the oxygen, but this, however, is claimed not to be the case. With the exception of a layer of 0.01 inch, at the most, next to the cutting edge, the material keeps its original chemical composition, and the physical qualities remain the same. It is claimed that pieces of iron up to a thickness of twelve inches may be cut by this process. Of course, the exactness of the cut changes with the different thicknesses. At a thickness up to 2 inches, the process may be carried out within limits of 3/64 inch, while at thicknesses of from 2 to 4 inches, the limit attainable is 3/32 inch, and above 4 inches it is still less. The width of the cut, of course, also increases with the thickness of the material.

The blow-pipes are connected with flexible piping to the tanks filled with the respective gases. As the pressure in the tanks is high, being about 150 atmospheres when filled, the gas passes through a pressure reducing valve before being used. The pressure of the oxygen, when used for cutting, varies, depending upon the thickness of the material, from about 1½ to 5 atmospheres.

As a matter of curiosity, some work done by the assistance of the hydro-oxygen jet may be mentioned; when visiting the Deutsche Oxhydric Co., the writer saw a large bunch of grapes with leaves and branch of the vine, which, by the aid of the hydro-oxygen flame had been made from ordinary thin sheet iron. The imitation was good and, although the piece was of iron, it was very light. There was also a branch of a pear tree, with a large, nice-looking pear, and two leaves, and also a lily of the valley made in the same way. As a souvenir, the writer received a cup made, during his visit, from welded pipe, by the aid of the same process. The pipe was chucked in a lathe and then heated by the gas jet, and at the same time pressed to shape by hand by a plane tool.

The Geared Head vs. the Cone Pulley Drive.

The following interview with Mr. Louis Montigny of the Werkstätte für Maschinenbau, Mülhausen, is interesting because of illustrating European views on this important subject. Mr. Louis Montigny is an expert on the design of machine tools, and has been employed as such in several shops both in England and Germany, and his views are therefore not only important as giving his personal opinions, but also because they, in a measure, embody the general opinions in this regard abroad.

"During the last few years," says Mr. Montigny, "it has been quite the fashion here in Europe to equip lathes with geared head drives, but it doesn't seem to be the fashion quite as much now as it has been, and we are now again building a great many lathes with cone pulley drives."

When asked whether he considered the geared head drive preferable for modern lathes, Mr. Montigny replied: "That depends on several conditions. The advantage of the geared head, as compared with the cone pulley drive, is, of course, the easier control of the speed changing device. By means of the levers provided it is much easier to change the speed, according to the size and the material of the work to be done than is possible to do with belts on cone pulleys. If an experienced man is running the lathe, the geared head is preferable, but if an inexperienced and unskilled man is working at the machine, it is likely to cause trouble, because of breaking the teeth in the gears or by otherwise getting out of order. A mistake with a change lever may cause considerable damage, and the machine has to be laid up for repairs for at least a few hours. This, however, won't happen as easily with machines driven from cone pulleys, because there are not as many parts to break, and besides the belt will slip easier and act as a safety device. The greatest advantage of the geared head is to be found when the lathe is used for heavy duty work, as for instance, when taking a heavy roughing cut. With the geared head the belt speed is usually higher, and therefore more power can be transmitted without the liability of the belt slipping. This also means more power at the cutting point, and consequently a heavier cut. For very smooth finish turning, however, it is my opinion that as good results are not obtainable by the geared head lathe as with one having a cone pulley drive, because, for this kind of work, it is of advantage to have the belt drive the work directly. Transmitting the power through a long train of gears, as is the case in the geared head drive, always means, with the ordinary accuracy obtainable in commercial gear-cutting, some little jars and jerks, caused by the play of the teeth between the gears, and the consequence of this jarring will be noticeable on the turned surface."

Trade Conditions in Belgium.

The machine tool industry, as well as the machine industry in general, seems to be in a less prosperous state in Belgium than in Germany. Some of the machine tool works are running with the force reduced 30 to 40 per cent. Times are, however, reported to be improving, and manufacturers are optimistic in their views of the future. Belgium, being a small country, and consequently having a more limited home market, has not got any large machine tool works, the largest shops for manufacturing machine tools being equipped for about 150 to 175 men. It is interesting, however, to notice to what an extent some of these concerns are specializing their manufacture. There are two concerns making lathes as a specialty, the Ateliers Demoor, Brussels, and Le Progres Industriel, Société Anonym, Loth, near Brussels, both employing about 150 to 175 men. These shops are equipped throughout in a modern manner for manufacturing lathes. The machines are usually built in lots of ten to twenty. The detailed parts, after each operation, are brought into the inspection department and inspected so as to prevent any further working on a piece that has been spoiled.

The system of paying is according to the straight piecework system, but the manager of the Ateliers Demoor seemed

to think a great deal of the bonus or premium system, and he is, at this time, working on the future application of this in the works. In fact, he already had this system applied in the erecting department, and stated that it had worked out so favorably as to save 30 per cent of the labor cost.

Another interesting shop in Brussels is that of the firm of Despaigne, a concern employing about eighty men. The specialties manufactured are bolt, nut, and thread rolling machines, and kindred kinds of machinery. The strong feature of this concern is some of their original designs, and of specially great interest is an automatic thread rolling machine in which a remarkably high speed is used.

Extended Use of Limit Gages.

It has been said about the German machine manufacturers that they have not as yet learned the extensive use of fine measuring instruments of which America boasts, especially of the micrometer. This is true, to a certain extent, but instead of going into the question itself regarding this, the writer wants to point out some interesting practice noticed in some shops on the European continent, and, in particular, in the two concerns in Belgium just referred to, who specialize in the manufacture of lathes. Generally speaking, the concerns in Europe have not as yet learned the full importance of specializing, but where this principle has been applied, the methods of manufacture are also modernized.

The two firms mentioned do not employ micrometers in their manufacturing to any large extent. For roughing work they use an ordinary pair of calipers. For the finishing work they use limit gages, not only for inspecting, but directly in the shop work. This, of course, is possible only when there is a specialization on a certain class of machines which are built in large numbers. The limit gages are of the double-ended type, where one end will pass over, while the other end must not pass over the work.. For internal diameters limit gages of the double-ended plug gage type are used. These limit gages are all made in duplicates, and one is used in the shop and one in the inspection department, so that the machinist and the inspector are always working with exactly the same kind of an instrument. Any opportunity for disputes, differences, or misunderstandings, is thus entirely precluded. For all work made in large quantities, all the measuring instruments are kept in sets, and are used for this particular work only, so that mistakes because of using wrong gages are eliminated. It is claimed by these firms that the constant use of limit gages in the shop is superior to that of using micrometers. It is also cheaper, because the cost of the gages, is, in the long run, not as high as the time lost by setting and adjusting micrometers. There is also a great advantage in the fact that the machinist always knows the limits of accuracy required on the piece of work he is finishing, and no time is wasted on finishing the work to closer size than necessary.

Machine Tool Business in France.

The conditions in the machine tool trade in France are improving, and dealers and manufacturers alike are optimistic about the future. This is partly due to the improvement in the automobile trade. The automobile factories in the vicinity of Paris, which the writer has visited, have a fairly large amount of work on hand, and the machine tool factories are also busy. The machine tool industry in France has not as yet, as far as the quantity is concerned, reached the same height as in Germany. Comparatively few machine tools are made here, and France is, to a large extent, depending upon American, English, and German imports for supplying the demand. Regarding the quality of the machine tools made in France, however, judging from the products of a few concerns, this can be put on a level with the German makers' products. One of the most important machine tool factories in the country is the firm of H. Ernault, Paris, employing about three hundred men. This factory is equipped with high-class machine tools, among which is a large number of the best American makes, especially in the gear-cutting department; the firm specializes in lathes, milling machines, and gear-cutting machines.

The Société Francaise de Machines-Outils, about which considerable has been written, occupies at present only a small plant employing about one hundred men. The building of the main works has progressed so far that some machines are being put in, and a few are already running there. The buildings are fully up to date in construction, and are to be equipped with several electric traveling cranes with a railroad track running through the building. Among the machines in operation were several American, English, French and German, all of high class. Mr. Nardin, the manager, is a very capable engineer, and said they intended to employ about seven hundred men when everything was running. All the castings are made outside, as they do not have any foundry of their own, and all the power running the machines and for lighting is brought from a large electric central station. At present the company is making lathes of a few types only, a gear head and cone head, and a turret lathe which they claim is an improvement over the Potter & Johnston machine; an automatic dowel pin machine, and a spur gear planer of Mr. Nardin's own design; but they intend also to take up the making of planers and vertical boring and turning mills.

American Manufacturers must Keep in Close Touch with the Foreign Trade.

In Germany the criticism in connection with American machine tools was more or less limited to the criticism of a few points of the design and the workmanship, although something was said, especially in Berlin, in criticism of the way in which the American machinery in general is introduced abroad. This point of criticism is put forth with much more force and emphasis in Paris. Because of the competition between American machines on the one hand, and German machines on the other, the French dealers and users have a splendid chance to compare the different methods employed. The dealers in Paris seem to think that the American manufacturers neglect the duties they owe to their European trade. Not only are conditions in Europe different from those in America, but those in one European country different from those in another, and it is of great importance that American manufacturers should study the local conditions, and conduct their business in each country according to these, and not according to the conditions in America. It is emphasized that American manufacturers who really want trade in Europe should either go over themselves or send some one, preferably one familiar with the language, to study conditions, and while there, to devote himself to business, and not to sightseeing and pleasure. One dealer pointed out the great success of two American concerns in introducing their products in France. One of these concerns represents the very highest class of machinery, while the other has not as yet attained for itself so high a reputation, but both concerns have from time to time studied the conditions, and conducted the business with due regard to local requirements. The success of the smaller firm mentioned proves that it is not only the very highest grades and classes of machinery that can be sold here, but also the medium grade, if sold at a corresponding price, provided it is properly introduced. As an instance of an American manufacturer neglecting his foreign trade, it may be mentioned that one dealer stated that about half a year ago he had signed a contract of agency for an American concern, but he has not as yet received any price list of the machines he is to sell.

A comparison has been made between the American and German ways of introducing their machinery in France, and the Germans are said to employ superior methods. Of course, they are nearer the territory, and are in possession of more first-hand local knowledge, and can therefore attend to their business better. France gives, however, the impression of being a better territory for American machinery than does Germany. The competition with the home manufacturers would not be keen here. It would, therefore, be deplorable if American manufacturers lost this opportunity as a consequence of neglecting to obtain sufficient local knowledge about the requirements to carry on business with the highest possible efficiency. If American manufacturers do not take advantage of the opportunity presented, there is no doubt that the German manufacturers will use this to their advantage, and gain thereby.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The spring meeting of the American Society of Mechanical Engineers was held in Detroit, Michigan, June 23 to 26, the headquarters being the Hotel Cadillac. The American Society for the Promotion of Engineering Education, the Society of Automobile Engineers and the Society of Gas Engine Manufacturers held their conventions simultaneously, thus making a large gathering of engineers in the city and stimulating the local members to provide unusual entertainments.

The program of the meeting was as follows:

Hoisting and Conveying Machinery............G. E. Titcomb
Continuous Conveying of Materials...............S. B. Peck
The Belt Conveyor......................C. Kemble Baldwin
Conveying Machinery in a Cement Plant......C. J. Tomlinson
Belt Conveyors.................................E. J. Haddock
Thermal Properties of Superheated Steam..Prof. R. C. H. Heck
Rational Method of Checking Conical Pistons for Stress, Prof. G. H. Shephard
A Journal Friction Measuring Machine..........Henry Hess
Surge Tanks in Water Power Plants....Raymond D. Johnson
Some Pitot Tube Studies............................ Prof. E. B. Gregory and Prof. E. W. Schoder
Comparison of Screw Thread Standards....Amasa Trowbridge
Identification of Power House Piping by Colors..Wm. H. Bryan
The By-Product Coke Oven..................W. H. Blauvelt
Power Plant Operation on Producer Gas........G. M. S. Tait
Horse-Power, Friction Losses and Efficiencies of Gas and Oil Engines.......................Prof. Lionel S. Marks
A Simple Method of Cleaning Gas Conduits......W. D. Mount
Economy Tests of High Speed Engines.............. F. W. Dean and A. C. Wood
Air Leakage in Steam Condensers...........Thos C. McBride

On Wednesday evening, Professor John A. Brashear, astronomer and scientist, of Allegheny, Pa., delivered an illustrated lecture, "Contributions of Photography to our Knowledge of Stellar Evolution," which was of extraordinary interest.

The five papers on hoisting and conveying machinery constituted a symposium on the mechanical handling of materials, a subject that has become of great importance within the last twenty years. The paper on identification of power house piping by colors was an account of the color schemes used in large power plants, distilleries, U. S. Navy, etc., with a recommendation that the time is now ripe for the adoption of a standard system.

A paper of much apparent value to hydraulic engineers was that by Raymond D. Johnson, "Surge Tanks in Water Power Plants." This paper describes the differential regulator for high head water powers and details a mathematical study for obtaining the capacity of the differential surge tank which reduces the maximum variations of pressure to less than 10 per cent of the total pressure. In view of the fact that many hydraulic engineers have contended that regulation of high head water power by other methods than that of deflecting the stream from the wheel or by-passing it and wasting the water, was impracticable, on account of the inertia of the water column, this development means much. Mr. Johnson gives the mathematical study of the subject, and taking a specific example, figures the maximum capacity of differential surge tank required for a given length of line and head. Where the nature of the installation is such that high surge tanks cannot be economically constructed, it is possible to use closed surge tanks with air chamber cushion. The principle, briefly, is that of differentiating the "stored" water from the "pressure" water. This is done by constructing the surge tank with a reservoir, preferably surrounding the surge tank, to which the surge tank communicates by ports near the bottom. The exterior of the combination resembles an inverted bottle, the neck connecting with pipe line. The combination reduces the size of reservoir 50 per cent and gives better regulation than possible with large surge tanks of the common form.

The event of the meeting of extraordinary engineering interest to many was the launching of a 10,500-ton steamer, *William B. Meacham*, Thursday, June 25, at the shipyards of the Great Lakes Engineering Works. This vessel is one of the largest of the lake steamers, having a beam of 56 feet and a length of 552 feet. The vessel was launched sideways, this being necessary on account of the narrowness of the Detroit River opposite the shipyard.

Among the plants open for inspection were those of the Burroughs Adding Machine Co., manufacturers of adding machines, and Parke, Davis & Co., manufacturing chemists. The Burroughs Adding Machine Co.'s factory is the largest of its kind, having a capacity of one finished machine for every 7½ minutes of working time. The highly developed mechanical, designing and experimental departments were open for inspection.

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Experiments have been carried on in Germany to ascertain the effect of titanium on steel and cast iron, and very satisfactory results have been obtained. The experiments were carried on with various titanium alloys in such proportions that 0.25 per cent of titanium was introduced in the final metal. The tensional strength of cast iron was thereby increased 35 per cent. Experiments carried on with Martin steel show increased tensional strength of the metal of from about 11 to 50 per cent. It has not been ascertained definitely in what way titanium influences iron, but it is assumed that the influence of nitrogen, the presence of which in iron is fully as undesirable as that of phosphorus and sulphur, is neutralized, and the material becomes more uniform and close-grained.

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OBITUARY.

Fred A. Johnson

Fred A. Johnson, president of the Gisholt Machine Co., Madison, Wis., died in Denver, Colo., May 26, of consumption. He was born in Madison in 1862, and received a mechanical engineering education in his father's works and the University of Wisconsin. Mr. Johnson was connected with the Gisholt Machine Co. since its incorporation in 1887 and became its president in 1901. He took a very active part in building up its business in Europe, spending several years abroad in the interests of the company. It was there that he contracted the disease which terminated in his fatal illness. Since 1904 he had been unable to attend to business.

I. Willard Beam, a well-known manufacturer's agent of San Francisco, Cal., died May 28. Mr. Beam was born in Newark, N. J., in 1854, and went to California in 1878 where he took the management of the California Wire Works. A few years later he started a business for himself, which was continued to the date of his death. He was the Pacific slope agent for William Jessop & Sons, and a number of other well-known manufacturers.

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PERSONAL.

Ernest L. Smith was recently appointed western sales representative of the Standard Roller Bearing Co., with office in Detroit, Mich.

T. F. Salter is now chief engineer of the Standard Roller Bearing Co., Philadelphia, Pa. Mr. Salter's previous experi-

ence was mostly gained in the field of hoisting and conveying machinery.

The honorary degree of doctor of engineering was conferred upon Angus Sinclair, the well-known locomotive engineer, author, and editor of *Locomotive and Railway Engineering*, at the 34th annual commencement of Purdue University.

Heinrich Dreyer, machinery merchant of Berlin, Germany, representing a number of well-known American machine tool builders, sailed for home June 23 after having made an extensive tour of the United States in the interests of his business.

Hugo Stokvis, head of the technical department of R. S. Stokvis & Son, Rotterdam, is on a business trip to the United States. His headquarters are with the A. S. Cameron Steam Pump Works, foot of 23rd Street, New York.

W. J. A. London has been made chief engineer of the Terry Steam Turbine Co., Hartford, Conn., succeeding C. E. Terry, recently deceased. Mr. London has had extensive experience in the turbine industry, having been with C. A. Parsons Co., Newcastle, England; the Brown-Boveri Co., Baden, Germany, and the British and American Westinghouse companies.

James S. Watson, manager of the drive chain department of the Link-Belt Company, has transferred his headquarters from the Philadelphia works to the company's chain manufacturing plant at Indianapolis. In his new field he will combine supervision of manufacture with direction of the selling force handling the Renold "silent" and roller chains.

C. S. Redfield, advertising manager for Yale & Towne Mfg. Co., New York, sailed in June, with his family, for a three-months' trip in Europe. Mr. Redfield was recently elected president of the Technical Publicity Association of New York, which has for its members the advertising managers of the largest machinery and manufacturing plants in the country.

W. O. Renkin, resident engineer, with Julian Kennedy, Sahlin & Co., Ltd., at Kalimata, India, has sent us two interesting photographs showing the character of laborers employed in building the works for the Tata Iron and Steel Co., Ltd. A preliminary work is clearing the bed of the Subarnarekha River for a dam, and the photographs show the Indian natives, in the native costume, at this work, and mixing concrete and laying the concrete bed for the dam.

James Cran, foreman of the blacksmith shop of the Pond Machine Tool Works, Plainfield, N. J., has loaned the Industrial Press the remarkable forgings made by him, which were illustrated in the May, 1901, issue of MACHINERY. One forging is a tobacco pipe, having a snake (hollow) for the stem, and the other is a calla lily with the blossom unfolding. Visitors to our office will be interested in these unique examples of artistic and difficult blacksmithing.

Prof. Arthur Lucian Walker has been appointed professor of metallurgy and demonstrating head of the department of metallurgy at Columbia University, to take effect July 1. Prof. Walker was born in 1863, and received his preparatory school education at Charlier Institute, New York City, and Morris Academy, Morristown, N. J. He was graduated from the School of Mines, at Columbia University in 1883, with the degree of Mining Engineer. He has had extensive professional experience with copper mining companies.

Charles H. Benjamin was made honorary doctor of engineering at the recent commencement of the Case School of Applied Science, Cleveland, Ohio. President Charles S. Howe, acting in accordance with the vote of the faculty and by authority of the board of trustees conferred the degree. Dr. Benjamin graduated from the University of Maine in 1881, receiving the degree of mechanical engineer. After graduation he remained with the University for a time as professor, and finally took up engineering work in the commercial field. A few years later he was made professor of mechanical engineering at the Case School of Applied Science, where he remained for a number of years. Last August he was appointed Dean of the School of Engineering, Purdue University.

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The fellow who waits for his ship to come in, very often finds that he's waiting at the wrong dock.—*The Silent Partner.*

AWARD OF THREE GOLD MEDALS FOR SAFETY DEVICES.

Three gold medals and diplomas of the American Museum of Safety Devices were awarded at a luncheon meeting held at the Engineers Club, New York, May 25. The medal offered by the *Scientific American* for the most meritorious invention in transportation was awarded to the Rich marine fire detecting and extinguishing system, and honorary mention was made of the Welin Quadrant Davit Co. and the Simmen Automatic Railway Signal Co. The jurors of award were Prof. F. R. Hutton, H. H. Westinghouse, Cornelius Vanderbilt, Samuel Sheldon, George Gilmour, John Hays Hammond, and Stuyvesant Fish.

For the best invention to reduce the perils of mining, the gold medal offered by the Travelers Insurance Co. of Hartford was awarded to the Draeger Oxygen Apparatus Co. The jury was W. R. Ingalls, Charles Kirchhoff and Prof. Henry S. Munroe.

For the best safety device to be applied to motor vehicles of either land or water type, the medal offered by Francis H. Richards, New York, was awarded to the Non-Explosive Safety Naphtha Container Co., New York, with honorary mention of the Rutherford Wheel Co. The jury was composed of Dr. Schuyler Skaats Wheeler, Casper Whitney and A. G. Batchelder.

The exposition of safety devices held in the American Museum of Safety Devices at 231 W. 39th St. in April and May, closed May 27. It attracted the attention of railway officials, architects, machine shop managers, industrial betterment workers, and others throughout the country, who have expressed their satisfaction with the character of the exhibition and have expressed the hope that the movement for a permanent museum will be successful. Dr. W. H. Tolman, the director, is working to establish a permanent museum. A number of prominent men have been interested in the work.

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NEW BOOKS AND PAMPHLETS.

TESTS OF CAST IRON AND REINFORCED CONCRETE CULVERT PIPE. By Arthur N. Talbot. 66 pages, 6x9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin is No. 22 of the series issued by the university recording the tests and experiments conducted in the Engineering Experiment Station. The results of these tests on culvert pipe indicate that the method of bedding and laying pipes, and the nature of the bed and surrounding earth have a great effect upon the bending moment developed and the resistance of the pipe to failure. A summary of the tests is given.

DIMENSIONS, WEIGHTS AND PROPERTIES OF STRUCTURAL STEEL SHAPES. 320 pages, 4x6¼ inches. Published by the Bethlehem Steel Co., So. Bethlehem, Pa.

This hand-book is of the same style as that issued by the Carnegie, Cambria, Pencoyd and other steel companies, giving tables of weights, supporting capacities and other properties of Bethlehem or Grey structural steel shapes. It includes both special and regular shapes and information and data concerning steel construction in general, together with useful tables, rules, etc., for engineers, draftsmen and others engaged in structural work.

BINDERS FOR COAL BRIQUETS. By James E. Mills. 56 pages, 6x9 inches. Published by the Department of the Interior, U. S. Geological Survey, Washington, D. C.

This bulletin, No. 343, contains an account of the investigations made by fuel testing plant, St. Louis, Mo., to determine the best and cheapest binders for making coal briquets. The importance of this problem is realized by all engineers who are familiar with the enormous amount of coal that, in the processes of mining, transportation and handling, disintegrates into fine coal, called "slack." Could this slack be cheaply made into briquets, it would greatly increase the available amount of our fuel resources. The bulletin records the results with binders of clay, magnesia, plaster-of-paris, Portland cement, natural cement, water glass, rosin, pitch, wood tar pitch, pine wood tars, fir tars, sulphite liquid, cornstarch, potato starch, producer gas tar pitch, coal tar pitches, graphite, petroleum residuums, water gas tar pitch, etc.

TESTS OF CONCRETE AND REINFORCED CONCRETE COLUMNS. By Arthur N. Talbot. 59 pages, 6x9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

Bulletin No. 20 records experiments upon concrete and reinforced concrete columns. A feature of reinforced concrete, in which architects and engineers are much interested is the column having the concrete hooped or bound with steel bands or spirals. Tests on this form of column reported from France and Germany indicate great strength, but the results have not been considered conclusive. The tests made by the Illinois Engineering Experiment Station are made to determine conclusively the applicability of reinforced concrete to building construction. The tests show that in hooped columns the steel hooping does not come into action to any great extent before a load equivalent to the ultimate strength of plain concrete is reached, and up to this point the action of the column is very like one of plain concrete.

TESTS OF A LIQUID AIR PLANT. By C. S. Hudson and C. M. Garland. 20 pages, 6x9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This bulletin is No. 21 of the series recording the experiments made by the University of Illinois Engineering Experiment Station. The plant on which the tests are made consists of a four-stage Norwalk air compressor and a Hampson liquefier of the laboratory type. The compressor was driven by a 15 horse-power Westinghouse induction motor. The tests were made to determine the power required

to liquefy the air, the cost of liquefaction, and the most favorable conditions for operating. The report touches on the efficiency of liquid air as a medium for the production of power. The ratio of the available energy of liquid air to the work required to produce it was calculated under various conditions, and it was found that *under the most favorable conditions not more than 2½ per cent of the work required to produce the liquid air can be recovered by using air to drive a motor.*

CATALOGUES AND CIRCULARS.

LACKAWANNA MFG. Co., Newburgh, New York. Catalogue of Lackawanna marine engines.

FRANK MOSSBERG CO., Attleboro, Mass. Special catalogue covering metal reels, spools and beams for wire manufacturing and the textile industry.

SIMMEN AUTOMATIC RAILWAY SIGNAL Co., Los Angeles, Cal. Booklet advertising the Simmen automatic railway signal, which was recently exhibited at the Exposition of Safety Devices in New York.

GISHOLT MACHINE Co., Madison, Wis. Bulletin illustrating standard type of Gisholt lathes, and 30- and 36-inch vertical boring mills and the Gisholt universal tool grinder.

ALLIS-CHALMERS Co., Milwaukee, Wis. Booklet entitled, "Works and Products of the Allis-Chalmers Co.," giving a brief illustrated account of the activities of this large concern.

HERMA SECURITIES Co., Kansas City, Mo. Booklets Nos. 1 and 2, "The Evolution of the Automobile," and "The Theory and Practice of the Dieterich Universal Drive Axle," both by L. M. Dieterich.

INTERNATIONAL ELECTRIC AND ENGINEERING Co., 148 Chambers St., New York. Catalogue of S & N heavy duty beam shears, coping machines, bar and angle cutters.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletins Nos. 4586, 4588, 4594 and 4595 on GI flame arc lamp, GE-202 railway motors, tungsten economy diffusers and aluminum lightning arresters, respectively.

PARK DROP FORGE Co., Cleveland, O. "Short Stories About Steel," being brochure No. 3, and having for its subject Henry Cort, and the Invention of Puddling and Rolling. Notes on special alloys of steel are included.

SAFETY EMERY WHEEL Co., Columbus Ave., Springfield, Ohio. Catalogue of grinding wheels and grinding machinery containing much valuable information upon the subject of grinding as adapted to modern requirements.

H. B. BROWN Co., East Hampton, Conn. Catalogue No. 12 of bolt and nut machinery. The bolt cutters are built under the Merriman patents, and the construction of the Merriman standard bolt cutter head is illustrated.

FOOTE-BURT Co., Cleveland, O. Catalogue of "Reliance" bolt threading, pipe threading and nut tapping machinery and accessories. The catalogue includes valuable data and gives instruction for making and recutting threading dies.

CINCINNATI PUNCH & SHEAR Co., Cincinnati, Ohio. Catalogue No. 11 of punching machines of various descriptions, including single and double punch or shear, heavy fish-plate punch, horizontal punch, multiple punches, geared shears, roll straighteners, bending rolls, etc.

FOGLESONG MACHINE Co., 127 Ringgold St., Dayton, O. Leaflet illustrating and describing the Dayton power hammer, designed to meet the demand for a first-class moderate priced machine, adapted to the requirements of general manufacturers, blacksmiths, wagon-makers, etc.

ELECTRIC CONTROLLER AND SUPPLY Co., Cleveland, O. Bulletin No. 281, descriptive of traveling crane fittings, such as knife switches, circuit-breakers, switchboards, cast grid resistance, coil resistance, type-B rosettes, type-B limit stops, universal insulator supports, Baehr flexible couplings, etc.

CROCKER-WHEELER Co., Ampere, N. J. Bulletins Nos. 96, 101, 102, 103 and 104 on alternating current switchboard panels, form D machines, A C switchboard panels, sanitary district of Chicago's hydro-electric development on the Chicago drainage canal, and direct-current railway generators, respectively.

CLEVELAND TWIST DRILL Co., Cleveland, O. Folder descriptive of the double tang sockets for twist drills, which were illustrated and described in the May issue of MACHINERY. These improved sockets enable broken tang twist drills to be repaired at small cost, so that they can be used until fully worn out.

CLEVELAND PUNCH & SHEAR WORKS Co., Cleveland, Ohio. Catalogue A, supplementing general catalogue No. 6 of punches, shears, rotary planers, bending rolls, jib cranes, punches and dies. The frames of Cleveland punches and shears are cast solid, thus eliminating cores and the troubles likely to arise therefrom.

GRATON & KNIGHT MFG. Co., Worcester, Mass. Booklet entitled "Glimpses of Modern Belt Making." It illustrates and briefly describes the manufacture of belting, from the time the hides are unloaded into the hide cellar until the belting has been loaded onto the delivery wagon and sent to the freight depot. The booklet is of unusual interest and will repay the attention of every user of belting.

THE BUCKEYE ENGINE Co., Salem, Ohio. Catalogue of "four-stroke cycle" gas engines, these being of what is commonly and erroneously known as the four-cycle type. The catalogue illustrates the action of the cycle, with diagrams, and gives a comparison of the thermal economy of gas and steam engines, also the thermal values of various bituminous and lignite fuels, which can be used in producer gas power plants.

WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburg, Pa. Circular No. 1068, descriptive of direct current motors, types S and SA, for constant, varying and adjustable speed. These motors are adapted to general manufacturing purposes, and the variable speed motor, type SA, is clearly suited to the severe requirements of machine shop practice.

BROWN CLUTCH Co., Sandusky, Ohio. Catalogue A, of Brown friction clutches, friction shaft couplings, hoists, pulleys, etc., for gas, gasoline and oil engines, line-shafts, boats and all friction power transmission. The catalogue illustrates the construction of the clutches and various applications, and includes useful rules and tables for users of hoisting engines and machinery employing friction clutches.

ALFRED BOX & Co., Philadelphia, Pa. Catalogue of electric traveling cranes, illustrated with views of crane installations and showing types of trolleys used to suit the conditions of installations. A view showing the great size of parts on large traveling cranes is that of a crane hook and sheave with man alongside, the latter being dwarfed by the comparison.

GISHOLT MACHINE Co., Madison, Wis. Booklet illustrating the application of Gisholt tools in railway shops, to the making of cross-heads, cross-head pins, rocker pins, studs, cylinder heads, pistons, bull rings, eccentrics, etc. The booklet specifically illustrates the set-up for making cross-head pins, finishing piston centers, finishing eccentrics, and finishing cross-heads. It will be found of much interest to railway mechanics.

SAFETY EMERY WHEEL Co., Columbus Ave., Springfield, Ohio. Catalogue No. 6 of emery wheels and grinding machinery. The catalogue is made with rounded corners and contains 185 pages, 6 x 9 inches. It illustrates and lists a large variety of grinding wheels and machines. Features of mechanical construction are shown in section, among which are the safety ring oiler, loose pulley construction, cushion bearings, etc.

LUFKIN RULE Co., Saginaw, Mich. Catalogue No. 7 of measuring tapes and rules, illustrating and listing the line of measuring tapes and rules made in a great variety of styles and lengths. The tapes are made of steel, linen and cotton for surveyors, builders, engineers, etc., with steel and leather cases, and the rules are made in all the sizes and styles required by draftsmen, machinists, bookkeepers, mill-wrights, carpenters and other workmen.

CINCINNATI SHAPER Co., Cincinnati, Ohio. Catalogue F, illustrating and describing the Cincinnati 16-inch single-geared crank shaper, the Cincinnati heavy-duty back-geared crank shaper, the heavy-duty triple-geared rack shapers, single and double head traverse shapers, and open side shapers. Each type is illustrated with half-tones clearly showing the construction. Some constructional details are illustrated by line engravings.

CRESCENT MACHINE Co., 56 Main St., Leetonia, O. Catalogue of wood-working machinery, including band saws, saw tables, disk grinders, shapers, planers, swing saws, boring machines and other wood-working machinery. The Crescent angle band saw illustrated and described in the May, 1906, issue of MACHINERY has a tilting saw frame, instead of the tilting table ordinarily provided. This enables the operator to work always on a level table, which is found particularly advantageous in pattern-making.

INTERNATIONAL TEXTBOOK Co., Scranton, Pa. Catalogue of the International Library of Technology, listing tables of contents of the reference volumes on civil engineering, chemistry, navigation, shop practice, sanitary engineering, commercial law, mining and metallurgy, mechanical engineering, mechanical drawing, electro-therapeutics, business, electrical engineering, telegraphy and telephony, architecture, structural engineering, art and designing, advertising, locomotive engineering, textiles, etc. These works represent an expenditure of $1,500,000 and are now placed on sale in volumes 6x9 inches, averaging 525 pages and 243 illustrations each.

CUTLER-HAMMER MFG. Co., Milwaukee, Wis., has just issued a 16-page pamphlet descriptive of its "Wirt-type" dynamo brush, designed for use with low tension direct-current motors and generators, alternating-current generators, plating dynamos, exciters, etc. The construction of the brush is fully described and illustrated in the pamphlet, which states that in designing a dynamo brush two conditions must be met in order to insure satisfactory operation. One of these is that the brush must be elastic so that it will make good contact with the commutator under slight pressure, disregard of this condition resulting in undue heating and rapid deterioration of both brush and commutator, due to friction. The second requisite is that the brush must be so designed as to oppose a high resistance to the wasteful and destructive current that is generated when adjoining commutator bars are short-circuited by the brush. The claim is made that the construction of the Wirt-type dynamo brush is such that these two necessary conditions are fully met. Elasticity is secured by constructing the brush of laminated strips of metal, while the desirable feature of high resistance is obtained by combining with the copper laminations, strips of a high resistance metal through which the wasteful current referred to is compelled to pass in completing the circuit from one commutator bar to another. In addition to the purely descriptive matter and price list, the pamphlet contains useful information on the care of commutators and brushes, the importance of correct lap, etc.

MANUFACTURERS NOTES.

THE STANDARD ROLLER BEARING Co., Philadelphia, Pa., has further expanded its sales organization by the opening of a branch office at 327 Jefferson Ave., Detroit, Mich. The Detroit office will be in charge of Mr. Ernest L. Smith, recently appointed western representative.

ERCOLE VAGHI & Co., Milan, Italy, is the present name and address of the concern formerly doing business under the name of Vaghi, Accornero & Co., dealers in machinery and tools for wood and metal working. Mr. Accornero will continue with the concern as its agent.

ROCKWELL FURNACE Co., 25 Cortlandt St., New York, with Mr. F. S. Garett, president, and W. S. Quigley, vice-president and general manager, has been organized to manufacture metallurgical furnaces, and fuel oil and gas burning appliances.

R. D. NUTTALL Co., Pittsburg, Pa., has added to its already comprehensive list of gears and pinions, the well-known Titan brand of manganese steel gears and pinions, having arranged with the Atha Steel Casting Co. for their exclusive sale.

STANDARD ROLLER BEARING Co., Philadelphia, Pa., has recently installed a thoroughly equipped testing laboratory in its factory, which is in charge of Mr. Walter H. Hart, an expert chemist, formerly connected with the Alan-Wood Iron and Steel Co.

CHARLES J. WATTS, for several years an expert accountant, well known in the machine tool trade in Ohio, has purchased an interest in the Owen Machine Tool Co., Springfield, Ohio. Mr. Watts has been made secretary and treasurer of the company.

NEW YORK BELTING AND PACKING Co., LTD., New York, recently received an order from Andrew Dall & Son, Cleveland, for the installation of interlocking rubber tiling for the Cuyahoga County Court House, Cleveland, Ohio, amounting to $125,000. It is believed that this is the largest order for rubber tiling ever placed.

THE CONSOLIDATED SUPPLY Co., 321 Dearborn St., Chicago, Ill., was recently incorporated to handle general steam and electric railway, mill and mining supplies. The incorporators are L. A. Hopkins, John P. Mahoney and J. L. Benedict. The three incorporators have had practical experience in the railroad supply business.

H. W. CALDWELL & SON Co., Western Ave., 17-18th Sts., Chicago, Ill., engineers, founders, machinists and manufacturers of elevating, conveying and power transmitting appliances, has opened a New England engineering and sales office, room 337 Oliver Building, 141 Milk St., Boston, Mass. The office is in charge of Mr. Malcom R. White.

THE S. OBERMAYER Co., Cincinnati, Ohio, publish *Obermayer's Bulletin* of foundry information. The June issue contains an article by Mr. R. H. McDowell, "Some Stove Foundry Experiments," which gives some personal experiences in this branch of the foundry trade. The bulletin contains other articles and items of interest to foundrymen.

CROCKER-WHEELER Co., Ampere, N. J., has removed several large trees and replanted them in different locations on its property. On June 11 an oak tree 60 feet high was lifted by the Crocker-Wheeler locomotive crane and carried 200 feet and replanted near the new post-office building. This work is being carried out in accordance with a comprehensive plan of making an attractive plant.

F. A. WELLES, 627 Main St., Waukesha, Wis., is the new address of the caliper factory conducted by Mr. Welles, in Milwaukee, Wis., for the past nineteen years. Waukesha is about eighteen miles west of Milwaukee. The new location is favorable for shipping, having three railways and an electric line. It is a healthful, beautiful city, making it a particularly desirable place for the manufacturing plant.

THE BUFFALO FOUNDRY AND MACHINE Co., Buffalo, N. Y., recently established a New York office at 143 Liberty St., with Mr. H. E. Jacoby as resident engineer and manager. The company makes large castings, and vacuum drying and impregnating machinery, vacuum drum, shelf and rotary dryers, compressors, pumps condensers, and the Bell steam hammer.

INDEPENDENT PNEUMATIC TOOL Co., First National Bank Bldg., Chicago, Ill., had a complete exhibit of Thor piston air drills, reamers, pneumatic flue rolling, tapping, and wood boring machines, portable pneumatic grinding machines, pneumatic chipping, calking and riveting

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hammers, pneumatic wood saws, and other air appliances, at the American Railway Master Mechanics' and Master Car Builders' conventions, held in Atlantic City, N. J., June 17 to 24 inclusive.

R. D. Nuttall Co., Pittsburg, Pa., has established a new department which will be devoted exclusively to the manufacture of gears for air compressors. The company has for some time been supplying gears and pinions for all the standard makes of air compressors, but owing to the rapidly growing demand for compressed air in a number of important industries, a special gear cutting department for this work was found necessary.

Joseph T. Ryerson & Son, Chicago, Ill., have completed their general offices and warerooms at 16th and Rockwell Sts. The old offices at Milwaukee Ave. and Lake St. were discontinued June 1. A downtown branch office will be maintained at the Commercial National Bank Bldg., and an hourly automobile service will be maintained to the general and branch offices, the automobile leaving the Commercial National Bank Bldg. on the even hours. The trip requires about fifteen minutes.

Westinghouse Electric & Mfg. Co. has acquired the Hadaway Electric Heating and Engineering Co., and has removed the offices and works from 238 West Broadway, New York, to East Pittsburg. The change will permit the business to be carried on on a much larger scale than heretofore, and all the standard appliances for hatters, confectioners, printers and other trades will be turned out in larger quantities. Special attention will be given to the manufacture of sad-irons, glue-pots, etc. A New York office will be maintained on the 22nd floor of the City Investing Building, 165 Broadway.

The Auto Paper Feeder Co., 198 Broadway, New York, the organization of which was noted in the June issue, was originally incorporated for the purpose of buying, selling, manufacturing, importing, exporting and generally dealing in all kinds of printing presses, paper feeders, etc., and to acquire or sell patents in the United States or foreign countries. Lately the capital was increased to $100,000 and patents for a new paper feeder were acquired. The present officers are Carl S. Hanau, president and secretary; Joseph Kleidmann, vice-president; and Rudolph L. Hanau, treasurer. Rudolph L. Hanau and Joseph Kleidmann are to be consulting engineers.

Ajax Mfg. Co., Cleveland, Ohio, recently entered into an agreement with de Fries & Co., Dusseldorf, Germany, by which the latter will manufacture and sell throughout Continental Europe and England the entire line of forging machinery made by the Ajax Mfg. Co., which line comprises rivet and bolt heading machines, upsetting and forging machines, bulldozing or bending machines, hot pressed nut machines, taper forging rolls, and universal forging machines, the latter being a combination of the standard upsetter and very powerful vertical side press. The above agreement is now in effect and all European buyers of Ajax forging machinery should apply to de Fries & Co. for prices and specifications.

COMING EVENTS.

July 24 to 25.—Summer meeting of the American Society of Heating and Ventilating Engineers, at Niagara Falls, New York. W. M. Mackay, P. O. Box 1818, New York City, Secretary.

August 18.—International Master Blacksmiths' Association Convention, at Cincinnati, Ohio. A. L. Woodworth, Lima, Ohio, Secretary.

MISCELLANEOUS.